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PLANIGRAPHY

I. INTRODUCTION AND HISTORY*†

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INTRODUCTION

PLANIGRAPHY is a method of roentgenographic projection of plane sections of solid objects. This may be effected by moving the point of emission of roentgen rays in one direction while the recording medium is moved in the opposite direction, the two being moved simultaneously in a constant ratio by means of a connecting system which rotates about an axis which lies in the plane of the section to be projected.

The practical realization of this can be achieved in the following manner (Fig. 1). *O* is the object of the plane section, *B*, of which it is desired to photograph. *T* is the anode of the roentgen tube (the point of emission of roentgen rays) which moves in the direction of the arrows during the time of the exposure of the film (the recording medium), *F*. *F* moves simultaneously in the opposite direction, the system, *T* and *F*, moving about an axis which lies in the plane *B* which is the plane to be projected. The ratio $TB:BB'$ is constant and therefore all points in plane *B* will be projected on corresponding points on the recording medium, *F*, while all points in planes *A* and *C* and other planes will be projected on various points on the recording medium. A correct image of the plane *B* will therefore be projected on the recording medium while the images of all the other planes will be blurred, the degree of blurring depending upon the distance of the other planes from plane *B*.

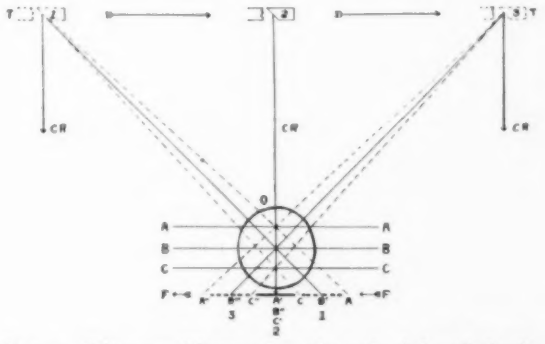

FIG. 1. Diagram illustrating the principle of planigraphy and planigraphic method No. 1 (Bocage). For explanation see text.

This has been demonstrated mathematically by Ziedses des Plantes,[27] Bartelink,[2] and Grossmann.[9]

HISTORY OF THE DEVELOPMENT OF PLANIGRAPHY

Methods No. 1, 2 and 3. Bocage[4] first described the principle of body section roentgenography in a French patent application on June 3, 1921. He proposed, in

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this application, three methods for the practical achievement of planigraphic projection. These were as follows (cited by Ott[11]):

1. The point of emission of roentgen rays moves, during the exposure of the recording medium, in a straight line in a plane parallel to the recording medium which moves simultaneously in the opposite direction. The central ray, *CR*, lies in a plane which is vertical to the plane *B* throughout the exposure. This is the method represented diagrammatically in Figure 1.

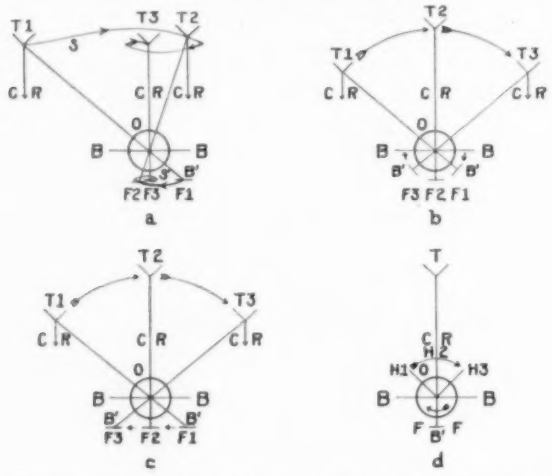


FIG. 2. *a*. Planigraphic method No. 2 (Bocage). *b*. Planigraphic method No. 3 (Bocage). *c*. Incorrect application of the planigraphic principle. *d*. Vallebona's original "stratigraphic" method (cf. Fig. 3). For explanation see text.

2. The point of emission of roentgen rays and the recording medium move simultaneously in parallel planes but instead of moving in straight lines they move in circles, squares, crosses, or in Archimedean spirals. Again, the central ray lies in a plane which is vertical to the plane *B* throughout the exposure. This method is represented diagrammatically in Figure 2, *a*, where *S* is the spiral course which is followed by *T* during the time of exposure. The recording medium moves in a similar spiral fashion, *S'*, and the ratio *TB*:*BB'* remains constant.

3. The point of emission of roentgen rays and the recording medium rotate about an axis which lies in the plane of the section to be projected instead of moving in parallel planes. Again, the central ray lies in a plane which is vertical to the plane *B* throughout the exposure. This method is represented diagrammatically in Figure 2, *b*. By this method the ratio *TB*:*BB'* is fixed throughout the period of exposure of the recording medium.

These methods will be referred to by number throughout this paper.

Figure 2, *c*, illustrates a principle which is very easy of practical application to many of the standard American roentgenographic tables but which represents an incorrect application of the principle. The source of emission of roentgen rays rotates about an axis which lies in the plane *B* and the central ray remains perpendicular to this plane. The recording medium, *F*, however, moves in a plane horizontal to plane *B* instead of rotating around the axis in the plane *B*. The ratio *TB*:*BB'*, instead of being a constant, varies throughout the range of motion of the system *T*-*F* and the projection of plane *B* will therefore be incorrect.

Portes and Chausse[13] described method No. 2 four months after Bocage and suggested its use in deep roentgen therapy for concentration of the depth dose.[11]

Pohl[12] described the principles of the method in a patent application in 1927.

Method No. 4 and the first practical medical application of the principle. Vallebona[14] was the first to put the method to practical use in the making of body section roentgenograms or "stratigrams," as this author termed them. His original method differed, however, from that of the other authors in that the point of emission of roentgen rays and the recording medium were held in a rigid system while the object itself was rotated during the exposure of the recording medium about an axis which lay in the plane of the section which it was desired to project. This method is represented diagrammatically in Figure 2, *d*, where *T* and *F* are fixed while the object, *O*, is revolved about an axis lying in plane *B*. A schematic

drawing of Vallebona's apparatus for the accomplishment of this is shown in Figure 3. The horizontal piece, *S*, supports the film over the center of which the tube is fixed as in ordinary roentgenography. The object to be examined is fixed to the rocker, *R*, which is pivoted, by adjustable pivot points, *P*, on the rocker arms, *A*, at the level of the plane to be examined and rotated by means of the handle, *H*, during the exposure of the film. With this apparatus Vallebona was able to make some planigrams of skulls, reproductions of which were published in his first communication on the subject. This method has not been developed further for medical roentgenography because of the practical difficulties encountered in placing and fixing the patient on the rocker. For this reason this method will not be considered further in this paper.

Vallebona did, however, employ the other methods and further elaborated on them. In 1933 he described a new improvement and published studies on it.[16] This method will be described as planigraphic method No. 4, "stratigraphy."

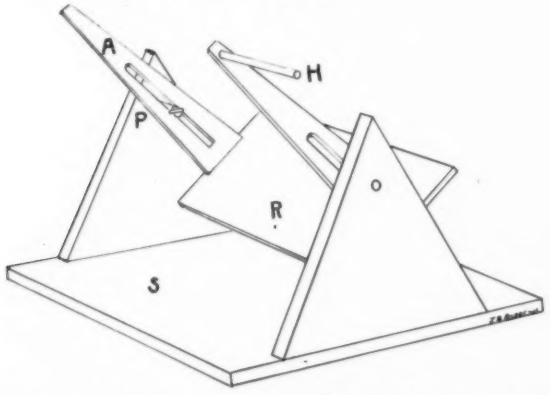


Fig. 3. Schematic drawing of Vallebona's original stratigraphic apparatus. For explanation see text.

Planigraphic Method No. 4, "Stratigraphy." The point of emission of roentgen rays and the recording medium rotate about an axis which lies in the plane of the section to be projected (as in method No. 3). With this method the central ray, instead of lying perpendicular to the plane of the section to be projected, lies perpendicular to the recording medium at all times and perpendicular to the plane of the section to be projected at only one point in the rotation. A schematic drawing of this apparatus is shown in Figure 4. The patient can be placed on a table over the film carriage and the pivot about which the system rotates can be fixed at any desired level on the upright standard while the patient-film distance can be varied by

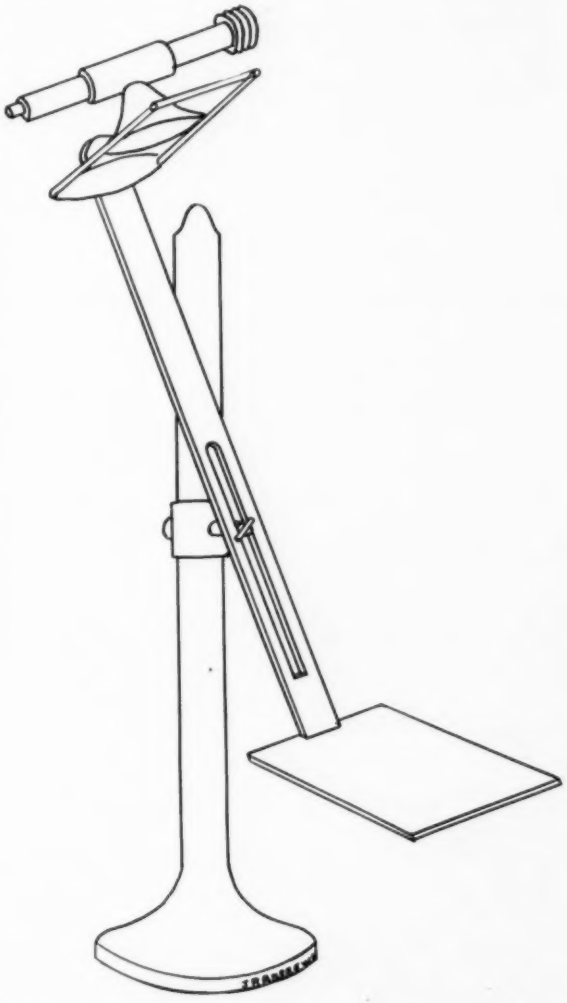


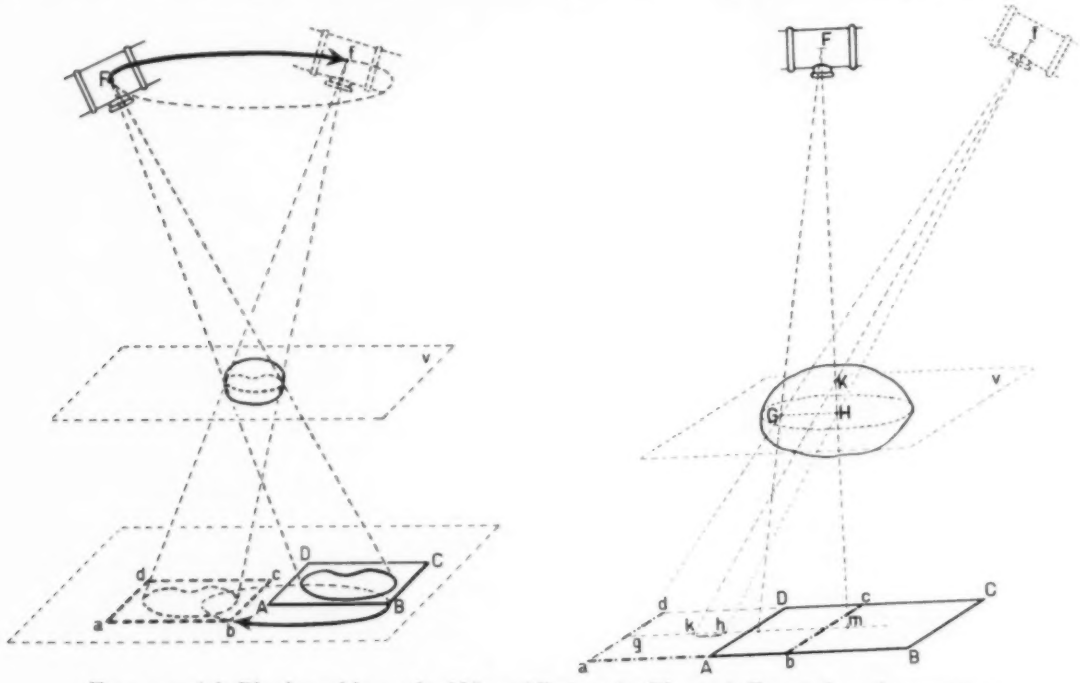
Fig. 4. Planigraphic method No. 4, "stratigraphy" (Vallebona). A pendulum-like arm is attached to the upright standard by a pivot, the height of which is adjustable. At the upper end of the pendulum the roentgen tube is fixed while at the lower end a cassette tray is fixed. The patient is placed on a table between the roentgen tube and the cassette tray.

means of the adjustable slide on the rocker arm. Here the ratio $TB:BB'$ varies with the adjustment of the sliding rocker arm but when this adjustment has once been made the ratio is fixed. This is a very simple and practical method.

Planigraphic Method No. 5 and the further elaboration of the principle. Ziedses des Plantes, in some personal communications and in his thesis for the doctorate degree,[27] states that he invented the method independently in 1921–1922 but was not able to work it out practically until 1928–1931 when he published his first paper.[21] Ziedses des Plantes was subsequently informed, in 1933,[27] that Bocage had taken out a patent in 1921 and Pohl in 1927 but that neither had put the principle to any practical use. He was also subsequently informed of Vallebona's work.

Whether or not Ziedses des Plantes should be given credit for independent origination of the method of planigraphy, although there is no doubt that Bocage, Portes and Chausse, Pohl, and Vallebona put the principle on record before Ziedses des Plantes, it remains, however, that his thesis for the doctorate degree is the most completely elaborated thesis of any of the few writers on this subject. For this reason his method will be described in detail in this communication as method No. 5.

5. The point of emission of roentgen rays and the recording medium move synchronously in parallel planes, circles, or spirals (as in No. 2 of Bocage). The central ray, however, is directed by simultaneous rotation of the tube toward the same point of the film at all times during the exposure (Fig. 7), and in this way this method differs from that of the other authors. This method is represented diagrammatically in Figure 5.



FIGS. 5 and 6. Planigraphic method No. 5 (Ziedses des Plantes). For explanation see text.

The roentgen tube and the film are moved during the exposure in such a manner that only one plane of the object (the plane v) is continuously projected on one and the same spot of the film. The projections of all other parts of the object are in motion. This is accomplished by simultaneous movement of the tube and film, the film moving from *ABCD* to *abcd* while the tube moves from F to f. This picture depicts a circular movement but in reality

Ziedses des Plantes generally uses a spiral movement in order to obtain greater blurring of the parts lying outside of the desired plane as he feels that with this spiral type of movement the absorbing areas not in the desired section are less disturbing in their projection on the film. This is apparatus which shows how the system moves during the exposure. When the tube, *R*, is moving with the support, *A*, the movement is conveyed to the film, *F*, by a lever, *H*, which is balancing at a point, *S*, which can be fixed at different heights. The tube, *R*, rotates during the movement so

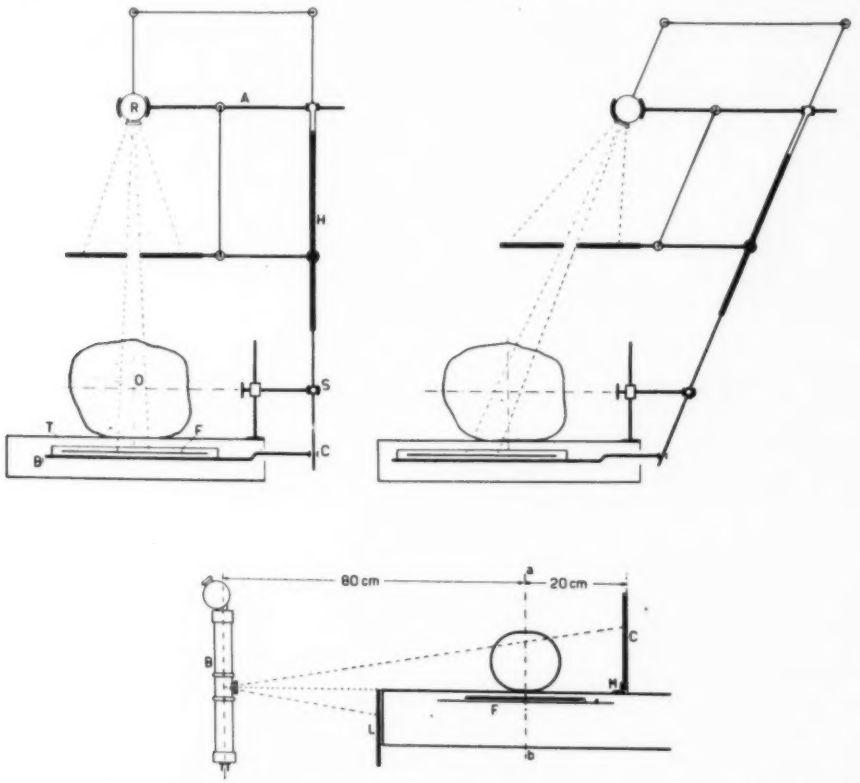


Fig. 7 (above). Schematic drawing of Ziedses des Plantes' planigraphic apparatus.
Fig. 10 (below). Diagram showing how the depth of the plane which is to be projected can be predetermined by making a lateral roentgenogram. For explanation see text.

especially true of parts bounded by straight or curved lines.

What takes place during the exposure can more exactly be demonstrated by reference to Figure 6. When the tube is moved from *F* to *f* and the film from *ABCD* to *abcd* the projections of *G* and *H* remain on the same points on the film. The projection of *K*, however, which at one time during the exposure lies on the same point as the projection of *H*, will later on have moved from *h* to *k*. As a result the image of *K* will be blurred.

Figure 7 is a schematic drawing of the that the central ray is directed toward the same point on the film at all times during the exposure. A diaphragm for the absorption of scattered radiation may be interposed between tube *R* and object *O*.

Figure 8 is a photograph of the apparatus which Ziedses des Plantes has been using for about five years. The tube, *R*, can be moved simultaneously with the whole supporting frame, *A*, in all directions horizontally, this being possible because the carrier, *K*, slides the length of the table while the frame, *A*, moves perpendicularly to it. The movement of the frame is trans-

FIG. 8. Photograph of Ziedses des Plantes' planigraphic apparatus. For explanation see text.

mitted to the plate by the lever, *H*, which is pivoted at point *S*.

The lower moving bar of frame *A* is attached by the cord, *D*, to the peg, *P*, on the floor. Manual turning movement of this lower bar of frame *A* during the exposure provides the motive power for the moving system. The turning movement will cause the cord to wind around the peg and therefore the moving bar and also the whole frame comes gradually to the center with a spiral motion. When a heavier peg is used, the spiral turns will be farther apart and therefore pegs of different sizes (*P-1*, *P-2*, *P-3*, and *P-4*) can be utilized according to necessity. Ziedses des Plantes also proposed the use of a slotted diaphragm or grid interposed between the object and the film for the absorption of the scattered rays.

Registration of the Depth of the Section of the Film. The depth of the plane section which is projected can be registered accurately on the film by the use of a small instrument which was designed by Ziedses des Plantes. This is a wood cylinder in which metal numerals have been placed, each numeral indicating its own height. Nine lead shot are placed in the cylinder between each two numerals, each one being placed a millimeter higher than the other. A lateral roentgenogram of this instrument is shown in Figure 9, *a*, while Figure 9, *b*, is a planigram of the instrument at the depth of 5 cm. and Figure 9, *c*, is a planigram at the depth of 5 cm. and 4 mm., the fourth shot being projected in the sharpest detail. In practical planigraphy this instrument is placed in the vertical position on the table beside the object to be examined and exposed simultaneously with the object and the film.

Figure 10 shows how the depth of the plane which is to be projected can be predetermined by making a lateral exposure of the object in the usual fashion and determining directly from the film, after making correction for the distortion of the projection, the height of the plane above the supporting table.

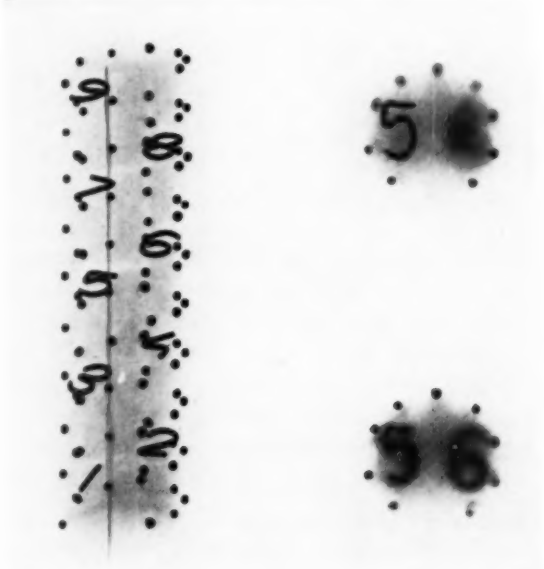


FIG. 9, *a*. Lateral roentgenogram of Ziedses des Plantes' instrument for registering the depth of the plane section which is projected. *b* (right above). Planigram of instrument at depth of 5 cm. *c* (right below). Planigram of instrument at depth of 5.4 cm. For explanation see text.

Fig. 11. Roentgenogram of dried skull.

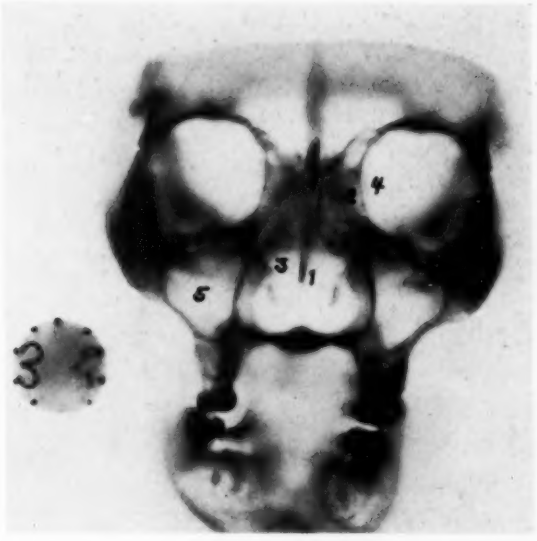


Fig. 12. Planigram of dried skull of Figure 11 made at a depth of 3.2 cm. from the most anterior part of the skull. For identification of numerals see text.

Ziedses des Plantes has made a special study of the normal and pathological anatomy of the skull and its contents. Figure 11 is a roentgenogram of a dried skull made in the posteroanterior projection. Figure 12 is a planigram of the same skull through a frontal plane 3.2 cm. (as indicated by the registering instrument) posterior to the most anterior part of the skull. The nasal septum, 1; some of the ethmoid cells, 2; the lower and middle turbinates, 3; the medial walls of the orbits, 4; and the walls of the maxillary sinuses, 5; are shown in

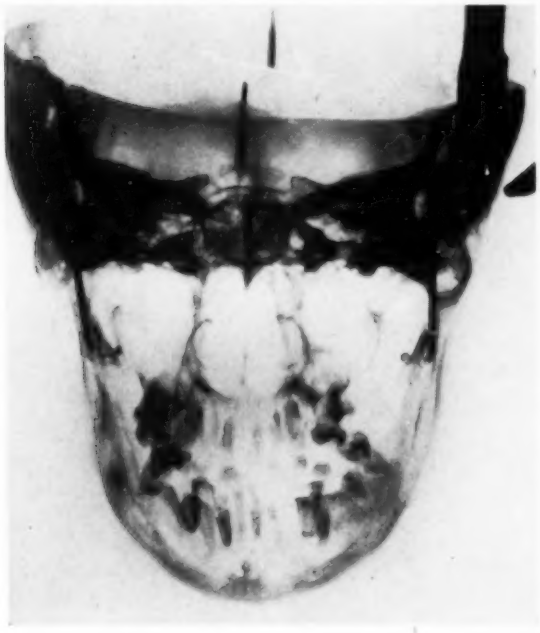


Fig. 13. Roentgenogram of dried skull.

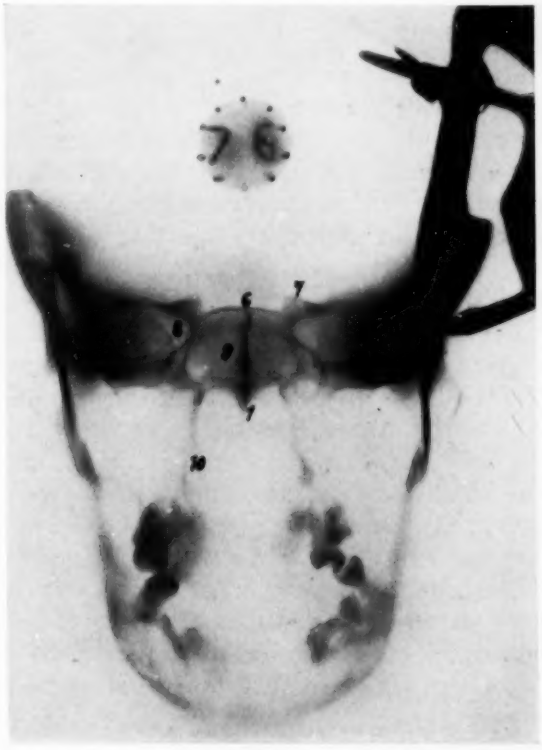


Fig. 14. Planigram of dried skull of Figure 13. For identification of numerals see text.

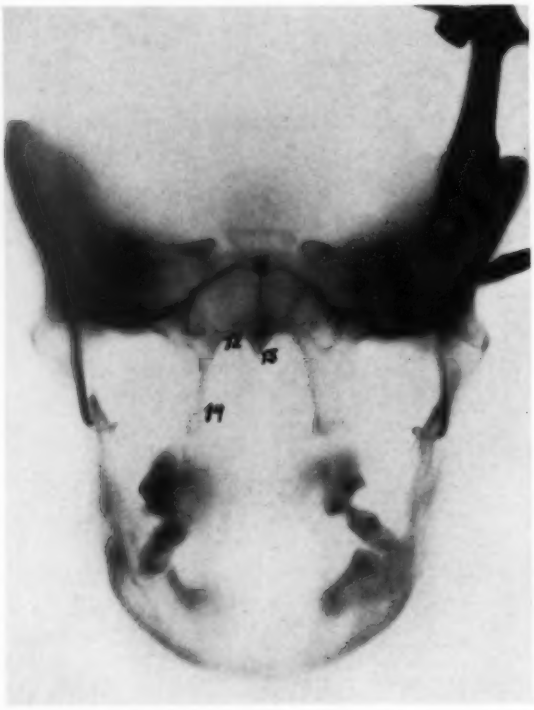


FIG. 15. Planigram of dried skull of Figure 13. For identification of numerals see text.

detail. Figure 13 is a roentgenogram of another dried skull while Figures 14, 15, and 16 are planigrams of the same skull made to show sections of this skull at different levels. Figure 14 shows the sulcus chiasmatis, 6; the anterior clinoid processes, 7; the superior orbital fissures, 8; the sphenoid sinuses, 9; the nasal septum, 1; and the posterior margins of the choanae, 10. Figure 15 shows the floor of the sella turcica, 11; the floor of the sphenoid sinus, 12; the ala of the vomer, 13; and the laminae of the medial pterygoid processes, 14. Figure 16 shows the dorsum sellae, 15; and the laminae of the medial, 14; and lateral pterygoid processes, 16. All of the lines shown on the planigrams are to be found in the ordinary roentgenogram but frequently they cannot be identified because of the confusion caused by the multiplicity of overlying lines and shadows. As shown by the planigrams the detail of any one section is good while the visualization and identification of that section is facilitated by the blurring of lines and shadows in the sections above and below the section which was projected.

After Ziedses des Plantes' first publication in 1931, Bartelink[1] demonstrated the results which he obtained by the use of a similar method at a meeting of the Dutch Association of Electrology and Roentgenology in Amsterdam on November 2, 1931. A schematic drawing of his apparatus is shown in Figure 17. The principle of this method is essentially that of method No. 4. In Bartelink's apparatus, however, the pivot about which the moving system revolved was fixed and the height of the object above the supporting table was altered to change the plane of the projection. This method is not quite so practical as that of Vallebona's.

In January, 1934, the firm of Siemens-Reiniger constructed a research model of a planigraphic instrument.

Planigraphic Method No. 6, "Tomography"; further refinements of the method. Grossmann[9] has made an extensive study of the mathematical and geometrical principles of planigraphy. He concluded that some of the previously proposed methods

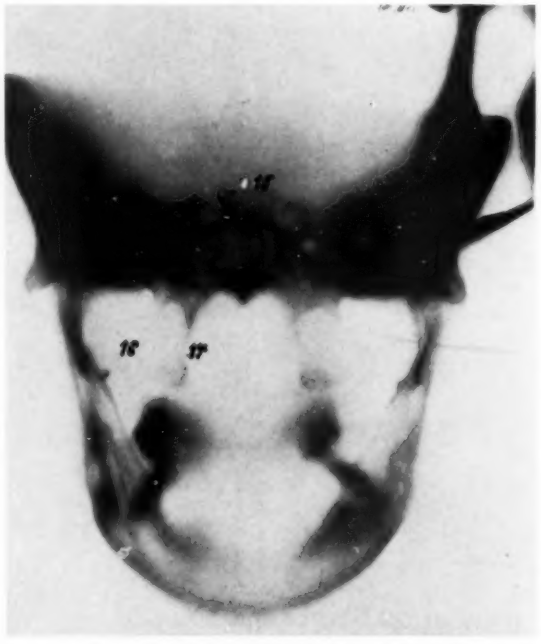


FIG. 16. Planigram of dried skull of Figure 13. For identification of numerals see text.

and devices have many disadvantages. Disturbing shadows of large surface area are not removed in many cases except by the formation of a more dense central shadow. He states that with circular movement not less than three to five times the normal exposure is necessary and, with spiral movement, not less than ten to fifteen times is necessary, which for practical reasons is difficult to obtain. The use of grids for the absorption of scattered radiation further increases the time of the exposure and further limits the application of the method. Furthermore, with the exception of Vallebona's apparatus, all of the devices utilized are very complicated for not only must the tube and film move, but the tube must permit oscillation along its longitudinal and transverse axes (this is especially true of Ziedses des Plantes' apparatus). In order to obtain clear planigrams with such devices, exact correspondence between the film and tube movement is necessary and exact adjustment of the apparatus is very difficult to obtain.

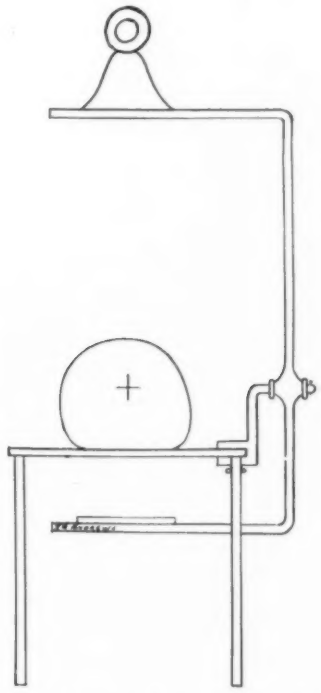


Fig. 17. Schematic drawing of Bartelink's planigraphic apparatus. The roentgen tube and cassette holder rotate about a fixed pivot, the height of the object above the supporting table being altered to change the plane of the projection.

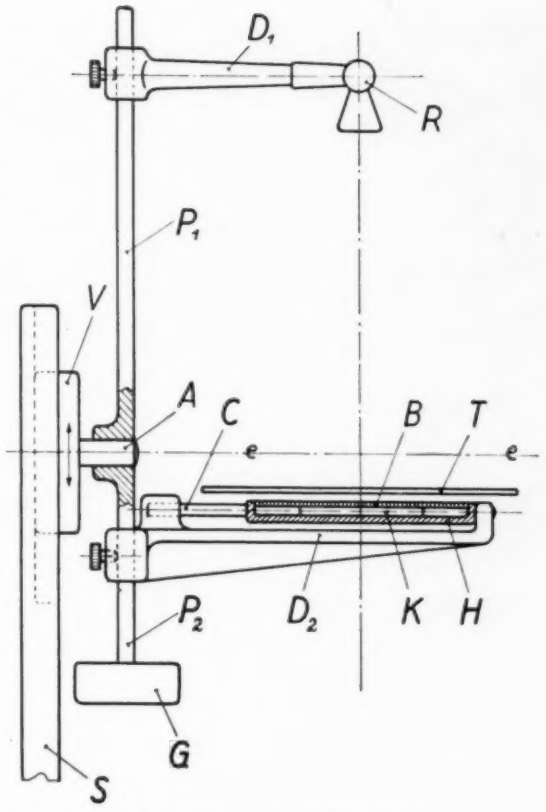


Fig. 18. Planigraphic method No. 6 (Grossmann). Schematic drawing of Grossmann's apparatus (tomograph). For explanation see text.

Grossmann describes a slightly different planigraphic method and has named the apparatus which he employs the "tomograph." The principle embodied in this apparatus will be described as method No. 6.

6. The principle which he employs is a slight modification of methods No. 3 of Bocage and No. 4 of Vallebona. The method and apparatus are represented diagrammatically in Figures 18 and 19. P_1 and P_2 are the two arms of a pendulum which rotates about an axis, A, the height of which is adjustable by the sliding frame, V, on the standard, S, and which lies in the plane Aee which is the plane to be examined of the object lying on the table support, T. G is a counterweight. Attached to arms, D_1 and D_2, which lie perpendicular to P

and horizontal to T are the roentgen tube, R, and the support (D_2) for the film cassette and grid. The distance of D_1 and D_2 from A is variable. H is a tray which is fixed to the axle, C, which is pivoted on the pendulum in the line RA and which carries the film cassette, K, and the grid, B. An extension piece is fixed to the tray, H, which is pivoted at Y (Fig. 19) to a movable arm, L, which in turn is pivoted to V and Z which also lies in the plane Aee. This system maintains the horizontal position of the film cassette and grid throughout the movement of the pendulum. It is this system which is distinctive in this apparatus and by which it differs from the methods No. 3 of Bocage and No. 4 of Vallebona. The central ray passes through the center of the plane to be projected at the point defined by the junction of the central ray and the line Aee at all times during the exposure while it is directed perpendicular to the plane to be projected at only one point on the rotation of the pendulum. Here, also, the ratio $RA:AC$ (cf. the ratio $TB:BB'$) is constant throughout the movement of the pendulum.

The pendulum is held by a catch with the tube, R, in position F_1. When the pendulum is released the weight and inertia of the counterweight carry the moving system through the tube position F_2 to tube position F_3 where the pendulum is automatically stopped by another catch. The tube is activated during the rotation of the pendulum, the exposure being started directly after the pendulum has been released and stopped just before the pendulum is stopped. The exposure may be started and stopped automatically by circuit breakers connected to the pendulum arms and stationary support.

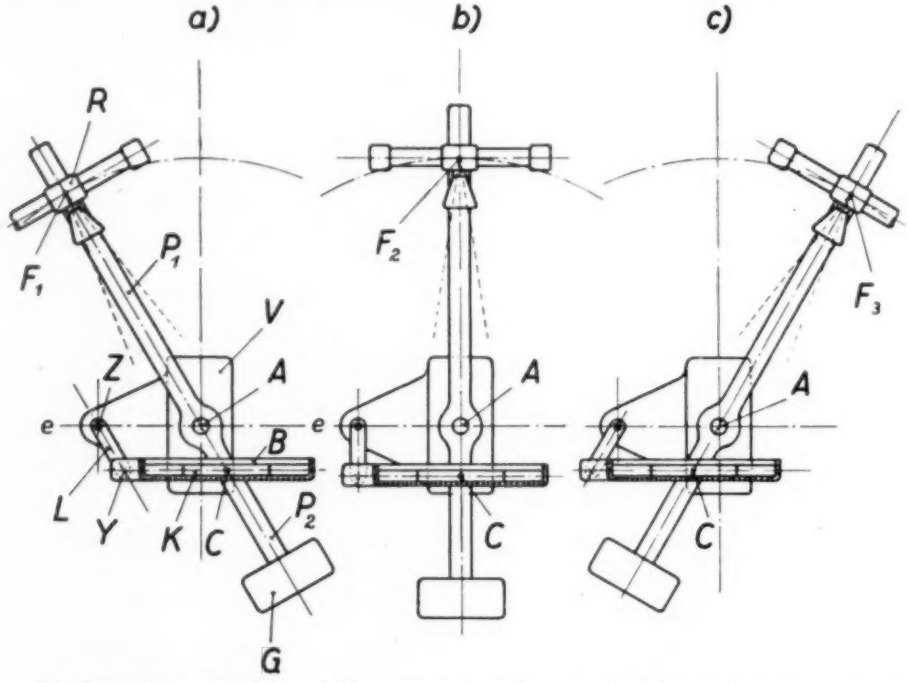


Fig. 19. Planigraphic method No. 6 (Grossmann). Schematic drawing of Grossmann's apparatus (tomograph). For explanation see text.

Grossmann's apparatus is now being manufactured commercially in Germany under the trade name "tomograph."

Grossman claims several advantages for this apparatus and a study of the plans leads to the conclusion that it is one of the simplest and seemingly most practical of the planigraphic instruments yet to be devised. He states that with this method large surface disturbing shadows are di-

minished while central shadows occur only in a few cases. Grids for the absorption of scattered radiation may also be employed without increase of the exposure time and short exposures (to one second) are rendered possible. He shows,[9] on the basis of geometrical and photophysical considerations, that disturbing shadows are more diminished by spiral motion of the focus than by circular motion. Such shadows, however, are effectively removed by the application of a pendulous motion to the tube focus of the tomograph provided that the focal excursion of the pendulous movement is sufficiently great that the larger disturbing shadows obtain a degree of diminution equal to that obtained with circular or spiral movement. This is shown diagrammatically in Figure 20.

Clinical and Pathological Application of the Planigraphic Method. Chaoul[5,6,7] has made a special study of the normal and pathologic anatomy of the lungs using Grossmann's tomograph. He shows, on the basis of many serial exposures, that the pulmonary vessels and their divisions and the bronchi and their related pathological conditions can be made apparent, cavities defined and localized, and the extension of pathological processes from focal pathologi-

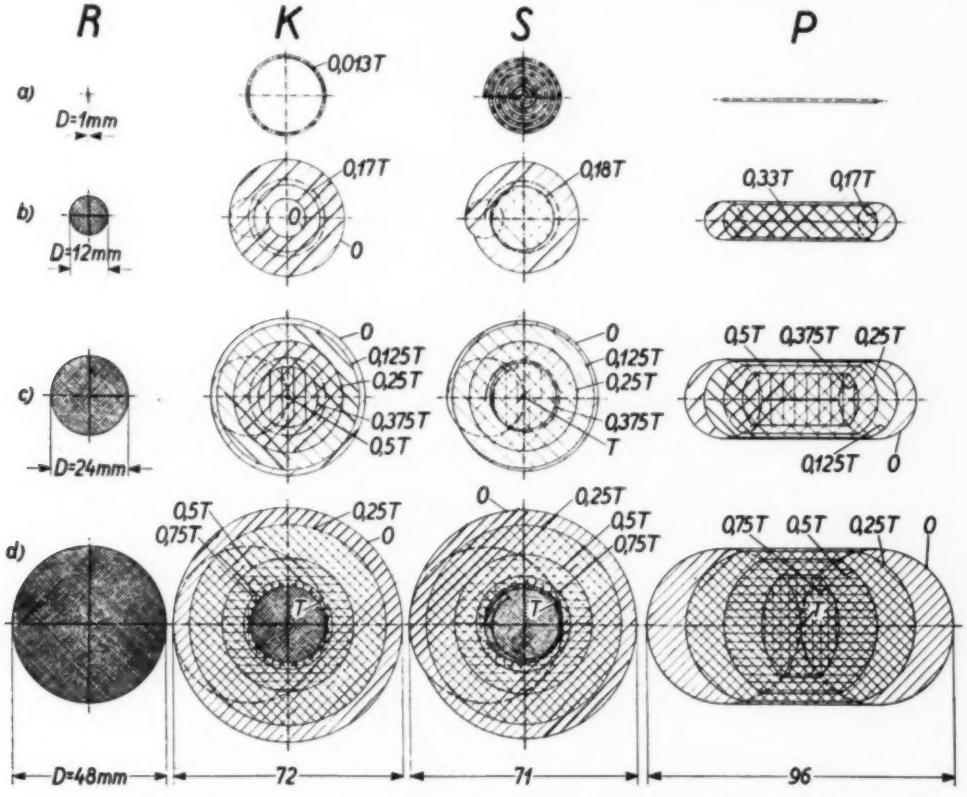


FIG. 20. The degree of distortion of circular planes (*a*, *b*, *c*, *d*) of different diameters lying 4.75 cm. from the plane of the section to be projected relative to the type of movement of the tube-film system (Grossmann).

The focal-projected plane distance = 80 cm.

The projected plane-film distance = 15 cm.

K, degree of distortion by circular movement.

S, degree of distortion by spiral movement.

P, degree of distortion by pendulous movement.

Greatest focal excursion in *K* and *S* = 16 cm. and in *P* = 32 cm.

The crosshatching indicates visually the relative density of the blurred shadows of the projections of the circular planes while the fractions of *T* indicate numerically the relative density of the blurred shadows compared to a standard density *T*.

cal processes can be estimated in a way which is not possible in the ordinary single or stereoscopic roentgenograms. His paper is illustrated with excellent roentgenograms and planigrams of the normal pulmonary anatomy, productive and fibrotic pulmonary tuberculous lesions, with and without cavitation, and pulmonary bronchiogenic cancer.

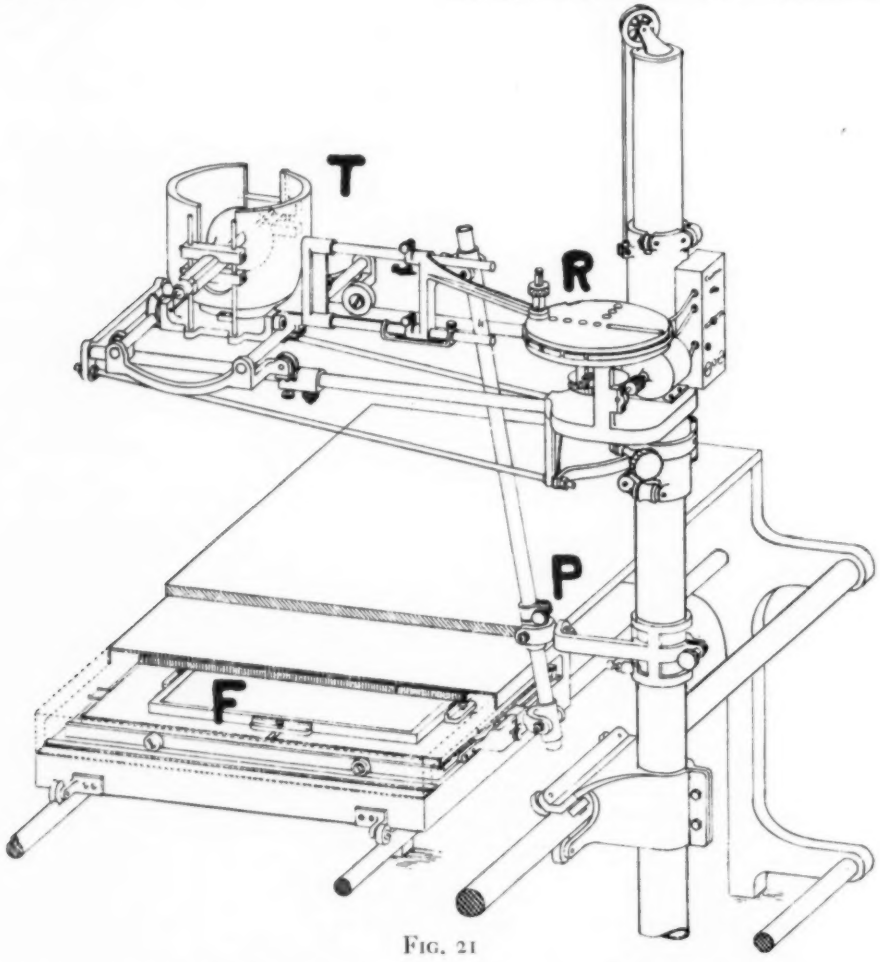


FIG. 21

Figures 3 and 4 are adapted from Vallebona.

Figures 5 to 16 inclusive courtesy of Ziedses des Plantes.

Figure 17 adapted from Bartelink.

Figures 18 to 20 inclusive from Grossmann.

In closing the first part of this study on planigraphy I wish to call attention to the use of the terms "planigraphy," "stratigraphy," and "tomography." The term "planigraphy," although I have not been able to trace its origin, apparently has been in use longer than the other terms. The former is derived from the Latin (planus, level) and refers to a plane surface; stratigraphy is derived from the Latin (sternere, stratum; to spread; biological: a layer of tissue) and refers to a tissue layer; and the latter is derived from the Greek (Τόμος, a piece cut off) and refers to a cut section. I would urge, because of its temporal precedence, the retention and use of the term "planigraphy" and the derivatives thereof when referring to the principle of body section roentgenography in general and the use of the terms "stratigraphy" and "tomography" and the derivatives thereof only when referring to special methods No. 4 (Vallebona) and No. 6 (Grossmann), respectively, in the application of the planigraphic principle.

Addendum. I have learned, since writing this paper, that Mr. Jean Kieffer, of Norwich, Connecticut, independently discovered the principle of body-section roentgenography and invented an apparatus for its application.

The apparatus was invented in 1929, at which time a patent was applied for in this country. This patent was granted in 1934. The invention of this apparatus in 1929, therefore, takes precedence over the work of Vallebona, Ziedses des Plantes, and Grossmann.

The inventor's drawing of his apparatus is shown (Fig. 21) through his courtesy.

The inventor has named his apparatus an "x-ray focusing machine" and the method employed is that which I have termed the "planigraphic" one. The roentgen tube, *T* (Fig. 21), is mounted on rails so that it may be moved in any direction in a horizontal plane. Motion is imparted to the roentgen tube through a rigid system connected to a rotating disk, *R*, which is motor driven and by which means a circular or spiral motion may be imparted to the tube. The roentgen tube and rotating disk system are connected to the roentgen film, *F*, by a lever hung in gimbals at *P*. The motion of the roentgen tube and rotating disk system is therefore transmitted by the lever to the roentgen film, *F*, which, with a slotted diaphragm, is mounted on rails so that it also may be moved in any direction in a horizontal plane. The plane of the object which will be projected is determined by the position of point *P* which is adjustable on the lever and upright tube stand.

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RADIOTHERAPY IN LESIONS ABOUT THE EYE*

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THE field of usefulness of any therapeutic agency as potentially dangerous as radium or roentgen rays naturally becomes a question of balance between the dangers on the one hand and the beneficial results on the other. If the dangers are too great and cannot be controlled, therapy must be restricted to desperate cases and hence usually to causes already lost. And there seems to be a widespread opinion, certainly among the laity and to a less extent also within the profession, that radium cannot be safely applied near the eye. This opinion has the proverbial grain of truth but as a general statement it may be accepted that the eye tolerates radium rather well—much better than some other structures—and with proper precautions radium may safely be used in a variety of conditions, the number of which is much greater than would appear at first glance.

DANGERS

The dangers are three in number: (1) corneal ulcer; (2) secondary glaucoma; (3) cataract.

(1) *Corneal Ulcer.* The first of these dangers is an immediate one due to the primary reaction and, if it occurs, carries with it all the possibilities for harm inherent in the disease. Corneal ulcers due to radium are very chronic, usually extremely painful, frequently fail to heal and of course may destroy the eye, either directly or by the development of the second of the complications, viz., secondary glaucoma.

(2) *Secondary Glaucoma.* Fortunately both of these complications are rare and should be largely avoided in the future by means of improvements in technique now well understood. The necessary precaution consists in placing over the cornea a gold or silver shield of sufficient thickness to protect the lens and the cornea during any treatment in which beta radiation is made use of. In cases in which this is impossible, only gamma rays should be used at a distance, and in all cases where it is possible to do so the lid should be so completely everted as to permit the application to be made some distance from the cornea. Further reference will be made to this presently.

(3) *Cataract.* The third danger, cataract,[1,2,3,4,5,6,7] is one of the late dangers and may be said to occur only as a result of long-continued applications of hard rays. Such an event may occur as an undesirable complication during the treatment of some disease not primarily in the eye at all, but in which treatment must be given under circumstances such that exposure of the eye cannot be avoided. Such misfortunes have been known to occur, for example, during the roentgen treatment of tic douloureux, in which the roentgen treatment relieved the pain for some months, at the end of which time it recurred and the treatment was repeated with a further period of relief. Under these circumstances, after some years a cataract developed in the eye on the side treated.

Numerous writers[1,2,3,4,5,6,7] have referred to such injuries to the lens as a possible sequel to radiation treatments coming on following treatment in periods all the way from six months to nine years. How frequent they are, or in what proportion of cases they develop, is almost impossible to state accurately. Judging by our own experience, the danger must be extremely remote as we have knowledge of only 2 cases.

Nevertheless because the possibility of

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such a danger exists, extreme care should be taken to completely shield the eye during all ordinary treatments in which there is any chance of the rays falling upon or reaching the eye. We apparently are faced with the curious paradox that radium rays may under some conditions act as a cause of cataract while the same therapeutic agent is recommended by some writers as a successful treatment for cataract. Similia similibus curantur?

Having thus briefly indicated the possible dangers, one may proceed to discuss a number of diseases occurring in or about the eyes in which radiological methods are of value:

BENIGN LESIONS

(*a*) *Blepharitis.* Infections of the hair follicles may be successfully treated by means of roentgen rays or radium, selecting for this purpose a type of irradiation similar to that used in chronic infections in other hairy regions of the body, as, for example, folliculitis barbae. The lids are everted, the cornea protected by a gold or silver shield which accurately fits over it and a light stimulating dose of unfiltered roentgen rays administered. This dose is in all respects the same as that used in treating sycosis, folliculitis barbae and other chronic infections when an epilating effect is not desired, and is approximately 25 per cent of an erythema dose. The exact details in our own work are: tube tension, 90 kv. (peak); distance, 10 inches; no filter; milliampere-minutes, 4; 150 r.

Such a dose may need to be repeated several times and if so this may safely be done at weekly intervals for three or four times. As a rule, it will be found to be effective promptly or not at all and if no benefit follows three or four exposures it is not likely to be successful and should be discontinued.

If epilation becomes necessary we recommend the use of radium and this will be discussed later.

(*b*) *Eczema of the Lids.* Granular lids or eczema along the edges of the lids usually responds well to unfiltered roentgen radiation, as does eczema elsewhere in the body. The treatment is carried out in the same manner as for folliculitis by means of several light stimulating doses at weekly intervals. As a rule, three or four applications will be found to be effective but if not the treatment should be discontinued. We believe general observance of this rule would remove any risk of harm from the method. Harm has come from persevering with treatment over a long period but never, so far as we are aware, from the use of a few exposures such as recommended above.

(*c*) *Inverted Lashes.* When the lashes become inverted from any cause and give rise to irritation of the cornea, the indication for treatment is epilation. By radiological means this may be accomplished either by roentgen rays or by radium, preference being in favor of radium.

The eye is cocainized as for any simple operative procedure and a gold shield inserted to completely cover the cornea. The affected eyelid is then everted and fixed in position by suitable packing and adhesive or a retaining stitch if necessary. A slit is then cut in a sheet of lead foil and through this slit the affected portion of the lid is allowed to protrude, all the other structures being protected by the lead. Radium is then applied to the exposed portion of the lid in suitable applicators with light filtration and the dose given is one known to be sufficient to destroy the hair follicles. This dose is also sufficient to cause a moderate tissue reaction coming on within two or three weeks after the treatment, but this should not cause more than slight discomfort. The advantage of this method is that the desired effect is usually obtained by a single treatment without much discomfort and is nearly always permanent. It is, however, possible for cilia to grow again even after a full dose of radium and therefore very occasionally the treatment would need to be repeated.

(*d*) *Papillomata.* Papillomata occurring along the edge of the lids present an interesting problem. As a rule, if radium is

used, the dose needed to cure the papilloma will also epilate the lashes, which is undesirable. Our practice for some years has been to destroy the greater part of the papilloma by single pole fulguration and follow this with a light dose of radium. If the electrocoagulation is deep, it will result in visible scarring and therefore must be used cautiously. But if the treatment were restricted to this procedure alone it would fail to permanently remove the lesion in a considerable number of cases. Hence, the combination of a comparatively light electrocoagulation immediately followed by a dose of radium insufficient to cause damage to the cilia will give very satisfactory results.

(*e*) *Vernal Catarrh.* The treatment of vernal catarrh by radium presents a technical problem of some slight difficulty owing to the fact that the treatment of the disease through the substance of the lids is dangerous to the lens and unsatisfactory, nor is it easy to apply the radium to the inner surface of the closed lids. The first method which meets the situation calls for the direct application of a relatively large quantity of radium in an almost unfiltered form, making use of a rich beta radiation. Indeed in such a treatment it is probable that the entire effect is due to beta rays.

In carrying out this method of treatment, the affected eye is cocainized, the lid everted and held in this position, and the radium preparation in a suitable forceps directly applied by hand by the operator and moved over the surface of the involved area in a manner which has been called "ironing." Each lid is thus treated in turn, the applications varying in time from five to fifteen or twenty minutes, depending upon the quantity of radium in the particular preparation being used, i.e., 500–1,000 mg-min. distributed over the whole lid. In young or very nervous children it may occasionally be necessary to administer a general anesthetic, and in this manner we have treated a number of cases in whom any such procedure would otherwise have been impossible.

The results of such treatment and the number of applications vary considerably, depending largely upon the severity of the disease. The average number of treatments in our own experience has been two, and the results have been satisfactory, though never brilliant.

A second very satisfactory method of treatment of vernal catarrh consists in cutting a shield of lead to accurately fit the surface of the tarsal conjunctiva and covering this shield of lead with active deposit of radium emanation, the shield then being placed in position under the lid. This method is slightly more difficult technically but insures uniformity and evenness of application. Such a method makes use of almost unfiltered radium and the dose recommended is 200 to 400 mc-min., the total exposure therefore being less than five minutes with an ordinary preparation. Such a technique does not call for repetition, as a rule, and should not be followed by any undesirable scarring in the lids.

(*f*) *Keratoses.* The treatment of keratoses on or about the lids does not differ from that of papillomata or similar pre-malignant lesions elsewhere on the body and is carried out by means of surface applications of radium. If the lesions are situated on the lids well removed from the lashes, the application presents no difficulties and a single application is usually sufficient. In case the lesion is directly over the lens when the lids are closed, the lens is protected by the use of the gold shield previously described—if not, no special protection is required. In lesions close to the edge of the lids and lashes, the only danger is epilation of the latter and in such cases the treatment is best carried out by means of several light applications some weeks apart rather than by a single heavier dose.

(*g*) *Nevi and Angiomata of the Lids.* The treatment of nevi of the lids is followed by extremely satisfactory results in the vast majority of cases, as is the case with nevi in general. This may be accomplished by either one of two general methods, the selection depending entirely upon the degree

of involvement in the particular case and more especially upon the depth to which the vessels extend. If the lesion is a capillary nevus limited to the skin, and in an accessible position, treatments may be carried out by a number of light applications of radium.

An excellent and satisfactory method is as follows: The lesion is shielded with a lead shield, an opening being cut to expose the nevus and a narrow margin of normal skin. Over the aperture in the lead is placed a piece of pure gum rubber (dental rubber dam) 1 mm. thick and upon this again the radium applicators. For this particular type of nevus 10 mg. needles of monel metal are satisfactory, using a dose of 40 to 50 mg-hr. per sq. cm.

Such an exposure is repeated at intervals of two to three or even four months, depending upon the degree of reaction. The ideal reaction is a minimal erythema without vesication. Gradually the color fades out and the ultimate cosmetic result is extremely satisfactory, if plenty of time is taken for the treatment.

If the lesion is a true cavernous angioma, we recommend the implantation of gold filtered radon seeds of 0.5 mc. strength and spaced rather more widely than would be the case in treating a malignant lesion. Such a treatment, if carefully carried out, seldom needs to be repeated. The vessels constituting the lesion slowly undergo fibrosis and ultimately disappear. It is important not to overdose such lesions as the very vascular tissue tends to break down, leaving an undesirable degree of scarring when it later heals in.

MALIGNANT LESIONS OF THE LIDS

(*a*) *Rodent Ulcer and Epithelioma.* In 36 unselected cases of malignant lesions about the eyes, 11 were diagnosed by biopsy as of the rodent ulcer type, 1 squamous cell epithelioma, 1 granuloma with secondary involvement of glands, 1 malignant endothelioma, 3 were epidermoid carcinoma, and the balance simply epithelioma. Only 1 of these 36 cases ever developed secondary glandular involvement.

In the group of 102 cases herein reported there were 3 failures, all the others having been cured so far as our present records have been able to follow them. The failures are as follows:

I. Female, aged seventy-two. Treated in 1928. There had been a previous excision followed by recurrence, a second excision and another recurrence. For this recurrence she was referred for radium treatment. She was treated in June, 1928, following which the lesion healed and remained healed for one year, after which recurrence took place in the retro-orbital space. Further treatment failed to control the growth, which finally destroyed the eye and became one of those very dreadful lesions in which the whole side of her face was destroyed, so that one could look directly back into the sphenoid sinuses. She finally died two years later.

II. Male, aged fifty-three. First treated in 1922. Originally he had a lesion on his upper lid which was cauterized and then excised. Following this it recurred and was treated by radium. It remained healed until August, 1925, when it recurred and was treated again. Following another recurrence his eye was removed and the opening closed with a skin graft. A recurrence developed under the skin graft and this resisted all forms of radium treatment, slowly extended, finally involved the bony walls of the orbit and became hopelessly incurable.

III. Male, aged fifty-four. The third failure probably should never have been treated. He had a very extensive mass projecting from the right orbit and, because the pathological report was basal cell carcinoma, treatment was undertaken on September 12, 1931. The mass did not respond as is usually the case in this type of growth and a second treatment was given on November 18, 1931. At this time he was showing very definite mental symptoms and died on November 25, 1931. An autopsy revealed the fact that the disease had extended along the base of the skull into the brain but had produced no signs or symptoms by which its presence could have been ascertained earlier.

It will be noted that in 2 of these failures previous excisions on one or more occasions had been carried out. A similar experience has occurred in other cases so that we feel justified in the statement that excision of

these lesions introduces a great and sometimes insuperable handicap to successful radiotherapy. We have no figures as to the percentage of successful results possible by excision alone, but there is no doubt whatever that if such an excision fails it very seriously jeopardizes the chance of success by radiotherapy and for this reason is probably unwise. If reliance against recurrence is to be placed upon radiotherapy as a postoperative procedure then the excision is unnecessary since the same radiological procedure which prevents the recurrence would have cured the original lesion and the only result of the combination is additional scarring and a poorer cosmetic result than would have been secured by radiotherapy alone.

FIG. 1. Lesion on the lid remote from either canthus. This particular case was epidermoid carcinoma. Cornea protected by gold shield during treatment.

From the viewpoint of radium therapy alone the cases may be divided into groups according to a number of different systems of classification. The present paper is based upon an analysis of the methods adopted and the results obtained in the treatment of 102 malignant lesions around the lids or edge of the orbit and the cases have been arranged according to the particular problem they present to the radiologist.

1. *Simple Rodent Ulcer on the Lid and Remote from the Lens or either Canthus* (Fig. 1). Such a lesion presents a comparatively simple problem—probably the simplest of all about the eye—and may be treated either by a surface application of radium or by the implantation of highly filtered needles. While there is perhaps not much choice between the two methods, on the whole the latter is rather more certain in its effect, seldom needs to be repeated, and is more likely to result in a permanent cure. If the lesion is known to be epidermoid carcinoma, it has the additional advantage of making it easier to deliver the necessarily heavier dose without sloughing of tissue.

Technique: Needles are used containing 10 mg. each of radium element (salt) per centimeter of length and having a wall thickness of 0.5 mm. platinum. These needles are implanted under local anesthesia, the number being determined by the size of the lesion. Our practice is to space these needles 2.5 mm. apart, i.e., five to 1 cm. of tissue and leave them in place four to six hours, the longer period only if there is much induration. One such treatment is usually sufficient and the cosmetic result following such a treatment is excellent.

FIG. 2. Early lesion near inner canthus without much ulceration. This was a case of rodent ulcer; single treatment.

Excision of lesions of this type is, we believe, an undesirable method of treatment, resulting in a degree of scarring and deformity which is usually unsightly and considerably less satisfactory than the results following radium.

2. *Lesions about the Inner Canthus.* The obvious dangers of such lesions are two in number: (1) destruction of tissue resulting in contracture and deformity of the lids, and (2) interference with the function of the lacrymal duct, resulting in a very troublesome epiphora. This may be due directly to the contracture just mentioned or to occlusion of the duct from the disease itself. The problem in treatment is to se-

FIG. 3. Early rodent ulcer involving inner canthus and surrounding lacrymal duct. Single treatment, no recurrence, no interference with the function of the lacrymal duct.

FIG. 4. Rodent ulcer involving inner canthus, with moderate ulceration. Single treatment by small pack, heavy filter. No recurrence, no interference with lacrymal function.

cure satisfactory healing of the malignant lesion with the least possible complication from either of these sources.

In the case of *early lesions without ulceration* (Figs. 2 and 3), almost perfect results may be obtained without either of the above complications. Frequently such lesions actually originate on the skin of the side of the nose and only involve the eye by extension later. At this stage, however, it is possible to obtain a very high percentage of permanent cures with almost no disfigurement and therefore there is little excuse for permitting them to progress until the eye becomes affected. Several of our patients postponed coming for treatment

FIG. 5. Rodent ulcer, inner canthus, with moderate ulceration. Single treatment by small pack, heavy filter; no recurrence, no interference with lacrymal function.

Fig. 6. Rodent ulcer, twenty years' duration. Treatment by implantation of highly filtered radium needles. Single treatment, no recurrence. Moderate scarring and epiphora.

because they had been told there was risk of injury to vision from the use of radium. Actually, the only risk is from delay in securing effective treatment.

With moderate degrees of ulceration (Figs. 4 and 5), healing may be secured with surprisingly little scarring or interference with the lacrymal duct, and the treatments are comparatively simple, either by surface applications, as already described, or by a small pack.

With *extensive ulceration* (Figs. 6 and 7) there has already been so much destruction of tissue that the primary object of treatment is to cure the disease, the cosmetic result being a secondary consideration.

Fig. 7. Rodent ulcer, ten years' duration. Treatment by implantation of highly filtered needles. Single treatment, no recurrence, no epiphora.

FIG. 8. Lesion close to or involving outer canthus but without much ulceration. This is a case of rodent ulcer, duration three years. Implantation of highly filtered needles, cornea protected. Single treatment, no recurrence.

Contraction and scarring are inevitable under such conditions and more or less permanent occlusion of the lacrymal duct is to be expected. Such lesions, as a rule, are better treated by heavily filtered radium in the form of needles embedded in the tissues than by any form of surface application. However, there are numerous exceptions to this statement and no fixed rule can be laid down. One can only express a personal preference in favor of the interstitial method as a first choice and an external application in the form of a highly filtered pack as second choice.

3. *Lesions near the Outer Canthus without or with Slight Ulceration* (Figs. 8 and 9).

FIG. 9. Rodent ulcer close to external canthus. Required two treatments. Slight scarring with epilation of cilia. No recurrence.

Fig. 10. Rodent ulcer involving outer canthus with extensive ulceration. Eight years' duration. Single treatment. Scarring and loss of tissue due to disease prior to treatment. There has been no recurrence in three years.

This group is intended to include lesions along the edges of the lids either upper or lower, close to but not actually involving the external canthus. Their treatment is usually quite simple, the only problem being that which is presented by the almost certain epilation of the cilia. Generally this would be considered of secondary importance. The treatment is carried out by everting the lid, shielding the whole eye and the other tissues by a suitable lead shield and applying radium either as a surface application or by the insertion of highly filtered radium needles, both of which methods have been previously described.

Fig. 11. Rodent ulcer, four years' duration. Very extensive with loss of tissue down to bone. Healed following two treatments. Marked scarring due to previous loss of tissue.

4. *Lesions Involving the External Canthus and Accompanied by Marked Ulceration* (Figs. 10 and 11). The seriousness of this type of lesion appears to depend very much upon whether or not it has become fixed to the bony structures of the edge of the orbit. In several cases in which this has happened failure has resulted and ultimately the disease has destroyed the eye, the bony wall of the orbit and terminated fatally by direct extension. In 2 such cases already referred to, the lesion had first been excised, which lends support to our opinion that excision is unwise in these cases.

Fig. 12. Hyperplasia of corneal epithelium. Treated by application direct to cornea through 1 mm. rubber secondary filter. Two treatments, no recurrence two years.

The actual details of the radium treatment are determined by the individual case but take the form either of a surface application as previously outlined, a pack applied externally or else the implantation of highly filtered radium needles, the latter being the method recommended if there is deep involvement or fixation of the lesion. The latter carries slight theoretical risk of radionecrosis of bone though we have not encountered this misfortune and think it deserves much less consideration than the risk of failing to control the disease. Our experience has been that the result of treatment will either be promptly and permanently successful or else that radium treatment will never control the disease, but that the lesion will continue to heal and break down repeatedly, until it results in very extensive destruction of tissue. This resolves itself into a slowly losing battle in which, in our hands at least, neither intensive high voltage roentgen therapy nor teleradium therapy (using a 4 gram pack) has materially altered the outcome or changed the course of events. It is therefore of the utmost importance that the disease be treated early and that the primary treatment be properly carried out.

Some of these lesions, on the other hand, tend to extend either along the lids or around the external canthus to involve the upper lid or the skin of the face. This frequently results in great destruction of tissue and marked disfigurement, all of which may easily be prevented by suitable early and effective treatment.

Diseases of the Eye Proper

1. *Lesions Involving the Cornea.*

(*a*) *Hyperplasia of the Corneal Epithelium* (Fig. 12). Simple hyperplasia of the

epithelium of the cornea is one of the very common degenerative changes of advancing years and in the vast majority of cases no doubt requires no treatment. In certain cases, however, the hyperplastic tissue may so encroach upon the cornea overlying the lens as to interpose a mechanical barrier to vision which calls for some measure of relief. Radium, by its property of destroying this proliferative tissue, offers a very easy and convenient means of removing the difficulty. Two treatments three months apart have been sufficient in the cases treated. The first application removed the bulk of the hyperplastic tissue and it is just possible that a single application might have been sufficient. However, at the end of three months, while there was no defect in vision, a thin film could still be seen on the cornea with a glass, and this disappeared completely following the second application. No undesirable reaction occurred at any stage of the treatment, almost no discomfort to the patient, and there have been no harmful sequelae in any cases treated.

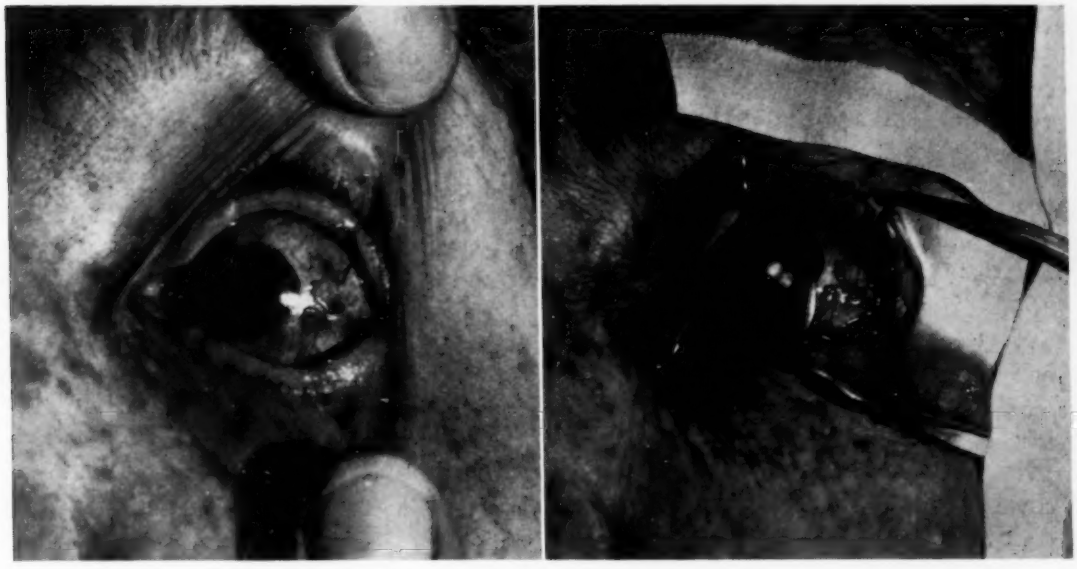

Fig. 13. Epithelioma of cornea. Application direct to cornea. Satisfactory result, single treatment.

Technique: The eye is cocainized. The lids are then retracted and held in position by retractors. A tracing of the hyperplastic tissue is taken on transparent celluloid and having transferred this to a piece of lead foil, an opening is cut in the latter as in the treatment of lesions on the skin. A piece of rubber tissue 1 mm. thick (dental rubber dam or its equivalent) is then cut to fit over the entire cornea extending down into each conjunctival sulcus, is sterilized and placed in position. Over this and in direct contact with it is placed the lead shield, over the aperture of which the radium is applied. In our cases the applicators have been monel metal needles containing 10 mg. each of radium element and these have been left in contact (i.e. with the rubber) for one hour, i.e., approximately 30–40 mg-hr. The rubber secondary filter is considered of especial importance.

(*b*) *Epithelioma of the Cornea* (Fig. 13). The technical problem presented by an epithelioma developing on the cornea differs from the treatment of hyperplasia only in the matter of dosage, the malignant lesion requiring a heavier application. Our experience is limited to the treatment of 2 cases, in which the lesion had previously been excised in whole or in part and in which the radium treatment was applied as a postoperative procedure. But there

seem to be no difficulties in applying the same method as the primary procedure and it is believed that in any case it should be considered before any suggestion of enucleating an otherwise good eye is acted upon. Our experience of 2 cases is obviously too limited to justify any conclusions except that the technique is simple. Both these cases have resulted satisfactorily so far as the lesions treated were concerned, though one patient died later of another disease.

All writers refer to the fact that the eye tolerates this treatment well. Inasmuch as most of these lesions would be recognized comparatively early and a biopsy is necessary, there seems no objection to the removal of the greater part of the lesion merely for purposes of biopsy and to follow this by the postoperative application of radium.

(*c*) *Diseases of the Lens.* Cataract has been treated by means of radium by several observers and there are a number of articles in the literature as far back as 1914. One of the most complete is by Cohen and Levin[8] in 1919. Their conclusions were that of 24 cases studied there had been some improvement in 87.5 per cent. The reports of later writers are not so favorable and the general conclusion which we have reached from a survey of the literature is unfavorable to this method as a means of dealing with the problem of cataract.

(*d*) *Intraocular Neoplasms.* Melanotic sarcoma: Melanomata in the eye may occur in the conjunctiva, in the iris and ciliary body and in the choroid.[9,10,11,12,13] A few workers have treated these lesions by the implantation of radon seeds directly into the tumor. An excellent article on the subject is that by Stallard[1] in 1933. While there appear to have been some evidences of preliminary improvement, the method is suitable only for rare cases in which the removal of the eye is contraindicated, and it is still the case that the most satisfactory treatment is enucleation of the eye followed by intensive and prolonged postoperative irradiation. Our own experience has been limited to this method of treatment by which 70 cases have been treated. The proper analysis of this material, and indeed of the whole problem, has proved to be so complicated as to make it unsuitable for inclusion in the present paper.

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DISCUSSION

Dr. Edgar W. Spackman, Philadelphia. I have listened to Dr. Richards' presentation with a very great deal of interest and satisfaction because the work which he has done and the results which he has accomplished have paralleled our work at the Wills Hospital for the Eye, in Philadelphia, almost exactly in every detail.

I have nothing further to add, but would like to especially emphasize four or five points which he brought out.

There certainly is no part of the body requiring greater care and accuracy in treatment technique than about the eye. We have, therefore, regarded roentgen rays less adaptable than radium for this work as radium can be placed very accurately and very small portals of entry used.

In the first place, the dangers of working with radium about the eye have been greatly exaggerated in the minds of the general practitioner and the laity. At the Wills Hospital, we have never thought it dangerous to give as much as two erythemas; in fact, we have often given five to six, and in malignancies, considerably more than this. We have not caused any corneal ulcers as far as we know that could be directly traced to radium treatment, nor have we had more than one or two cases that could be regarded with suspicion as far as glaucoma or cataract is concerned.

Therefore, our experience has been that this danger in the application of radium or roentgen rays to the eye has been considerably exaggerated. I believe there is a reason for that. I believe with insufficient infiltration, you are liable to have more trouble. I think the total dosage must be considered in all cases and we must not give repeated doses, especially to nonmalignant conditions without keeping in mind how much we are giving as our total dosage.

The second point is, in treating vernal catarrh, we have used a slightly different method than that of Dr. Richards. We have everted the lid and applied the radium direct, by the so-called ironing method, giving treatments every week to ten days, 10 mm. bare steel needles, from six to eighteen minutes' application. Our results have not been very good as far as the appearance is concerned. As far as the subjective symptoms are concerned, we have had great relief but at least 50 per cent of our cases have recurred the following year.

The third point is, in treating nevi and hemangioma, our experience has been that the slower they have been treated, the better. I think the mistake often made in treating these birthmarks, especially about the eye, is in attempting to treat them too rapidly. We have therefore given treatment approximately every two to three months instead of weekly or daily to these cases, and over a period of five years have had very good results.

Next, we are mistaken sometimes in these innocent lesions, especially along the tarsal border. We cannot emphasize too strongly getting a biopsy in every possible case, whether we are going to fulgurate it or treat it with radiation.

Next, in malignancy, we have been impressed very greatly in these questionable cases, especially about the canthi where there may be extension back to the alveolar tissue, and have insisted in every case on enucleation, not necessarily before commencing treatment but some time during the treatment.

I would especially like to ask Dr. Richards what his results have been in cases where the globe has become involved and treated without enucleation. Our results have been rather poor. After enucleation, we have packed the orbit with radium, applied radium packs or the 4-gram radium bomb and cross-fired with deep roentgen therapy from every possible direction.

Dr. Walter S. Lawrence, Memphis, Tenn. Owing to the fact that this Society carries the name of the American Roentgen Ray Society, I think our attention might be called to the fact that most of the results, if not all, that Dr. Richards has shown us here can be had with roentgen rays instead of radium. I second entirely what Dr. Richards said about the tolerance of the eye. At the Tennessee Academy of Ophthalmology, I found the idea prevailed, that he has mentioned, among laymen and a great many physicians. They are all afraid of treating around the eye with roentgen radiation. I have done a great deal of this work in years gone by and I have never seen any regrettable sequelae from using roentgen radiation around the eye.

In 1931 I treated a case with as much as 3,200 r, giving half through the front of the eye, and half of it laterally. The diagnosis had been

determined by incision through the temple. The lymphosarcoma was so extensive that it couldn't be removed. High voltage roentgen therapy removed the tumor and left the woman able to work at her position as stenographer to this day.

I would also like to say that these little papillomas which occur on the margin of the lids are very easy to treat. They can be removed, all of them, by fulguration carefully done, without leaving any scar whatsoever. A scar is a lesion that you are attracted to the moment you see the patient. Here, if you part the lashes a year later and look where the little growth was, you may be able to see a scar but it does not spoil the lashes. I suppose I have removed two hundred of them.

One other point, I would like to ask more about the epitheliomas of the conjunctiva beginning at the nimbus and making a little tumor nourished by a nest of congested blood vessels. I have treated, in all, eight cases of that kind. I treat them with unfiltered roentgen rays, parting the lids and holding them apart with a lid retractor, and giving about an erythema dose, certainly the first one is a little less, and I have seen them disappear and not reappear within the last two years.

DR. RICHARDS (closing). In reply to Dr. Spackman's question as to the treatment of lesions which have involved the retro-orbital tissues or the eye itself, we feel under those circumstances the prime requisite is to save the patient's life even if this necessitates the sacrifice of his eye, and we hardly have an opinion as to which of the two methods is preferable. We have deliberately irradiated these by the 4-gram radium bomb until the disease seemed to be controlled. In doing that, we set up a secondary glaucoma which required removal of the eye. Or, secondly, we have deliberately removed the eye and administered treatment postoperatively by the same method.

As to the relative merits of radium and roentgen radiation, I have a paper in preparation for one of our Canadian societies which I have called "The Biological Conception of Dosage," in which I have expressed the opinion that in these superficial lesions of small size, it is entirely immaterial whether you use roentgen rays or radium so long as you give an equivalent dose. I don't think I would have any doubt at all that the same results could be obtained by unfiltered roentgen rays or by radium. I think that radium is an instrument of a little greater precision in these small lesions but that is all. So far as the therapeutic results are concerned, they should be equal.

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ROENTGEN THERAPY OF THE PELVIS IN THE TREATMENT OF CARCINOMA OF THE CERVIX*†

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A COMPLETE statistical examination of the results obtained at the Institut du Radium of Paris University in cases of carcinoma of the cervix uteri will be published shortly. The statistics will cover the years 1919–1929. We shall therefore in this paper content ourselves with but summary indications of the results obtained in our department at the Curie Foundation by the use of roentgen rays, either alone or associated with radium. We shall confine ourselves essentially to a description of the roentgen technique which we have used in our material consisting of cases of Stage III carcinoma, extensive invasion of both parametria, reaching the wall of the pelvis, and of a number of extensive recurrences after operation.

A. MATERIAL

A division of our material into three groups according to the era of treatment will permit a better appreciation of the progress made between the years 1919 and 1929, the period under discussion.

(a) 1919–1922. During this period the roentgen therapy was of but limited efficiency. The tension was low, scarcely 170 kv., the total dose low, always less than 6,000 r, the daily doses high, for example, 800 r. Treatment occupied but fifteen or twenty days. Two to four fields were used, each about 400 sq. cm. in area, at a skin focal distance of 50 cm.

During the course of these four years of investigation the roentgen rays could be considered as an imperfect supplement in cases too extensive to be treated by intracavital radium alone. There were no five year survivals in this group.

(b) 1923–1927. During this period the kilovoltage reached 180. We gradually learned how to apply a dose of double the foregoing to the pelvis, that is, about 12,000 r. The fields were increased in number to ten, whereas their size was reduced to 200 to 300 sq. cm., on occasions to even less than 200 sq. cm. The focal skin distance was increased to 70 cm. The maximum daily dose was reduced to 500 or 600 r, and the duration of treatment was increased to twenty-five to thirty days and then gradually to forty and even to forty-five days. This increase in time was not the result of therapeutic considerations, strictly speaking, but rather was dictated to us by the necessity for preserving the general condition of the patient.

In several cases we thought that an unsatisfactory result was due to treatment over too long a period; we returned therefore to the short treatments lasting thirty-two, thirty, or twenty-five days, or even less. This reduction in the time of treatment was accompanied by an increase in the proportion of accidents and sequelae due to treatment, and there was no increase in the number of cures. Nevertheless, taking cases of Stage III and the postoperative recurrences together, we find for this period a five year survival rate of 20 out of 71, or 28 per cent. For the Stage III cases alone, we find a survival rate of 19 out of 60, or 30 per cent.

During this period we began to realize not only that external roentgen irradiation was a very valuable adjunct to intracavital curie therapy in Stage III cases but also that, unassociated with radium, roentgen rays could, in certain cases in which intracavital therapy was impossible, be made to yield satisfactory results. Not only could the carcinoma be made to disappear from

* Translated from the French by Dr. R. Stewart-Harrison, Pasadena, California.

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the parametria, but also the primary lesion could be healed, which from the point of view of external irradiation is usually a more difficult problem.

(c) 1928–1929. In 1928, our collaborator, Baclesse, took special charge of the investigation and treatment of the cases of cervical carcinoma and his results and conclusions have assumed an ever increasing importance.

Baclesse was of the opinion that the first duty was to avoid accidents due to treatment. This led him to maintain the duration of treatment at first at thirty-five to forty days, subsequently to increase to forty-five to fifty days. As a result of this increase and of a better and closer knowledge of the local and general effects of radiations, he was able to give doses of 13,000 to 14,000 r. The increase in time of treatment and reduction of the daily dose made it possible to avoid dangerous reactions, useless suffering and even excessive fatigue. At the same time there was an improvement in the results which, for the Stage III cases alone, reached 36 per cent.

Equally, after 1923, there was a steady improvement in the results obtained among the patients treated with roentgen irradiation alone, although they were very inferior to the results obtained by the associated method.

Technique. To illustrate the technique that we have employed, we will commence by reporting 2 successful cases. The first was treated by roentgen rays associated with radium, the second by roentgen rays alone.

It must be strongly emphasized that the details of dosage do not represent an inflexible scheme of treatment and are only to be used as an indication of the order of magnitude. The doses given were measured on the skin, with back-scattering, by a thimble chamber recording dosimeter. The dose of each treatment was measured directly.

Roentgen therapy associated with intracavital curie therapy.

CASE I. Madame Mer., aged thirty-nine, weight 65 kg. Epithelioma of the cervix invading the whole of the right parametrium and part of the left parametrium.

September 8, 1924. Beginning of roentgen treatment: 180 kv., 4 ma., filtered through 2.5 mm. Zn, skin focus distance 55–65 cm; eight fields: the right and left iliac fossa, the right and left lumbosacral regions, the right and left gluteal regions and two laterals; field area, 380 sq. cm. The fields overlapped at their edges. Two treatments were given daily, one in the morning, one in the evening; ten or eleven treatments a week. Duration of each treatment 50–75 minutes; dose per treatment, 150–200 r during the first twenty-eight days, then an interval of nine days on account of fatigue and finally treatments of 250–300 r during the last ten days. The fields were irradiated in rotation, the same fields never being treated twice consecutively.

October 23, 1924. Conclusion of roentgen treatment. Total dose: 10,300 r in fifty hours spread over forty-five days. Approximately equal doses were given on the right and left sides.

October 25, 1924. Intracavital radium treatment. Dose: 29 millicuries-destroyed in the uterus, 26 millicuries-destroyed in the vagina; total, 55 millicuries-destroyed, or 7,300 mg-hr. Duration of the treatment: five days excluding one day's interruption.

October 30, 1924. Conclusion of radium treatment. Total duration of two associated treatments: fifty-two days.

February 15, 1935. General and local condition excellent. Skin aspect normal. Survival at present is ten years.

Roentgen therapy alone, without curie therapy.

CASE II. Madame Po., aged forty-eight, weight 60 kg.

May 11, 1926. Total hysterectomy for carcinoma of the cervix.

January 9, 1927. Extensive recurrence invading the whole of the right parametrium. Suspected invasion of the left parametrium. Definite invasion of the right wall and of the vault of the vagina.

January 10, 1927. Beginning of roentgen therapy: 180–190 kv., 4–5 ma., filtered through 2.5 mm. Zn; skin focus distance 57–75 cm. Eleven fields: right and left iliac fossa, right and left gluteal regions, right and left lumbosacral regions, and in the midline, one suprapubic, one vulval, one perineal, one anal and one sacrococcygeal field; field area, 400 sq. cm. for the lateral fields and approximately 150 sq. cm.

for the median fields. Some of the fields overlapped slightly. Two treatments daily, one in the morning and one in the evening. Duration of each treatment fifty to sixty minutes. Dose per treatment 150 r during the first week, 200 r during the course of the second and third weeks, 250 r during the fourth and fifth weeks. The fields were irradiated in rotation as far as possible.

February 11, 1927. Conclusion of treatment. Total dose: 11,200 r in forty-five hours spread over thirty-three days. The right side and the middle of the pelvis received 8,500 r, the left side of the pelvis, 2,700 r.

1935. Excellent condition locally and generally. Survival at present eight years.

It is worthy of note that in this second case, although intracavital radium was not employed, it was not necessary to increase the dose of roentgen rays seriously in comparison with the first case which was treated by roentgen rays associated with radium.

B. TECHNIQUE OF ROENTGEN TREATMENT AS EMPLOYED AT PRESENT

(1) *General Principles.* At present we are using a tension of nearly 200 kv., a current of between 4 and 5 ma., a filtration of 2 mm. Cu, and a skin focus distance of from 70 to 90 cm. The intensity varies between 3 and 5 r per minute. The total dose and daily dose will be discussed below.

The intracavital curie therapy has been developed into a method which now remains fairly constant. The anatomical conditions of the region favor the use of radium intracavitally in a way that is not found for the other localizations of malignant disease. The details of the intracavital treatment are determined by the local pathological conditions for the greater part, whereas the details of the roentgen treatment are chiefly determined by the general condition of the patient.

The dose of radium is usually close to 60 millicuries-destroyed (8,000 mg-hr.), 30 in the vagina and 30 in the uterus. According to the local condition (extent of infection, patency of the cervix, elasticity of the vagina), the uterine and vaginal treatments are carried out simultaneously or consecutively. The radium treatment usually occupies about six days. It may be a day shorter or it may be increased to eight or ten days.

The details of the radium treatment as carried out in these, as in the other cases of the Institut du Radium by Regaud and his collaborators, have been described in various publications[1,2,3] and reference should be made to these standard publications.

In the material under discussion, intracavital radium treatment has been carried out in every case in which it was possible either before or after the roentgen treatment, though usually after the latter. When associated, the two treatments are placed as close together in time as possible. The fact that external irradiation leads to a reduction in infection and of hemorrhage is an indication for commencing an associated treatment with external irradiation as the first act. In the cases treated with roentgen rays alone, the essential contraindication to radium treatment was the extent or type of the local region resulting in the technical impossibility of satisfactory intracavital curie therapy, e.g., disappearance of the cervical canal, inelasticity of the vagina due to spread of the disease or severe purulent infection. In those cases which are treated with roentgen rays and radium it is necessary to reduce the roentgen dose to some extent, though this reduction is not marked and should not exceed 20 per cent of the dose that would have been given if treatment had been confined to the use of roentgen rays. In the case of associated treatments, the roentgen radiation is directed chiefly to the parametria although it is evident that the cervical region will receive a very nearly equal dose.

Universal experience has shown that intracavital radium alone will lead to successful treatment in comparatively limited

[1] Regaud, C., and collaborators. Sur la technique de la curiethérapie dans le cancer du col de l'utérus. *Bull. Ass. franç. p. l'étude du cancer*, 1920, *6*, 224–257.

[2] Lacassagne, A. La radiothérapie des épithéliomas du col utérin à l'Institut du Radium de Paris. *Arch. de l'Inst. du Radium*, 1932, *2*, 95–129.

[3] Coutard, H., and Regaud, C. Résultats et technique de la roentgenthérapie dans les cancers du col de l'utérus. *J. de radiol. et d'électrol.*, 1926, *10*, 152–154.

cases of carcinoma of the cervix whereby the duration of treatment need not exceed six to ten days. On the other hand, as our results have shown, roentgen rays alone are capable of yielding cures in more extensive cases that are not amenable to any form of intracavital curie therapy, but, in these cases, it has been necessary to adopt treatments lasting from thirty-five to fifty days. The intracavital curie therapy produces strictly local effects and a caustic destructive action of the radium being limited to non-vital regions may be accepted. In the case of roentgen therapy, this is not so and it is necessary to find a method of treatment producing effects on the neoplasm sufficiently intense to cause its eventual disappearance and at the same time to avoid the production of serious irradiation effects on the other tissues, necessarily irradiated, the volumes of which are large and whose functions are important. An increase in the duration of treatment seems to make this possible.

It is then possible to cure carcinoma of the cervix with extensive invasion of the parametria with a tension of 200 kv., but the treatment is long and difficult in the average case and the results become very unsatisfactory as soon as the patient exceeds a weight of 70 kg. It seems possible that the treatment may be slightly shortened and considerably facilitated by even a moderate increase in the tension. Thus a tension of 300 kv. would be a definite improvement not only because the percentage depth doses could be increased but also because the effects on the vascular connective tissues might be reduced. There would therefore be less reduction of the radiosensitivity of the epithelioma during the course of treatment. As a result certain new growths regarded at present as radioresistant might be found to be relatively radiosensitive.

(2) *Details of the Roentgen Therapy*

(*a*) *Daily Dose, Total Dose and Duration of Treatment.* It is true that intracavital curie therapy has a tendency to increase a pre-existing local infection, but its great advantage lies in the fact that by this means it is possible to bring the energy exactly where it is needed in a cavity walled off by soft tissues of comparative thickness. The roentgen therapy, on the other hand, may cause the reduction or even the disappearance of infection and hemorrhages but the energy destined for the cervix must cross the lower half of the abdomen and the bony structure of the pelvis, and may therefore affect the general condition deleteriously.

It is necessary to consider the susceptibility and to avoid an early intolerance on the part of the patient. For this reason it is usually advisable to start with small doses and increase them subsequently, particularly if the fields are large.

Thus we have started treatment with doses of 100–125 r per seance, or 200–250 r daily. After the first week the patients will often tolerate larger doses and we have usually been able to give doses of 300–350 r daily to be increased again after the second or third week to 400 or even 500 r daily. This dosage may be continued for a week or two, as in the case we have described.

As far as possible general effects of the irradiations are to be avoided. Thus vertigo, sickness, sensations of muscular fatigue, particularly of the legs, cardiac troubles such as increase in the pulse frequency, arrhythmia or drop in blood pressure are an indication not to increase the intensity of treatment unless they are slight and evanescent.

In general terms, we do not exceed 10,000 r in five weeks, 12,000 r in six weeks, 13,000–14,000 r in seven weeks. Our experience leads us to believe that a cure may be obtained with a dose in the neighborhood of 12,000 r when it is necessary to treat the whole of the pelvis (bilateral parametrial invasion), a dose which is reduced to 7,000–8,000 r when but half the pelvis needs treatment (unilateral parametrial invasion).

Towards the thirteenth or fourteenth day certain patients showing a predisposition may present signs and symptoms of an irritation of the intestinal mucosa, the first sign of which is an increase in the frequency

of the motions. One is forced to reduce the daily dose at once for the intensification of such symptoms could compel the termination of treatment before the total dose was sufficiently high to permit a successful result.

The appearance of local reactions of the integuments and general reactions on the part of the patient at a later stage of the treatment is due to excessive daily doses, having regard to the size of the patient, the thickness of the abdominal wall and of the layer of fat which protects the gut and to other pre-existing factors such as the degree of infection, the blood condition and, of course, the previous intracavital radium treatment, if any. For such reasons it will often be wise to reduce the daily dose. It is very necessary to avoid, if possible, the late intestinal reactions which may appear about the twenty-sixth or the fortieth day which can develop into severe radio-epithelitis of the mucosa, and the reactions of the vulval, the perineal and inguinal skin which may appear from the twenty-second to the twenty-eighth day. During the course of treatment, particular attention should be paid to keeping these regions dry and clean.

(*b*) *Number of Fields, Size of Field and Dose per Field.* At least four fields must be employed if a dose of 10,000 r is to be reached. This gives a dose per field of 2,500 r; 2,500 r may be considered as a maximum dose per field when the latter approaches 400 sq. cm. and should not be given in less than thirty days. When the duration of treatment reaches fifty days, it is possible to increase the dose per field to 2,800 r but above this figure permanent skin changes are likely to appear.

The dose per seance for a field of 400 sq. cm. does not exceed 200 r; for a field of 300 sq. cm. it may reach 250 r. Two different fields are irradiated daily, the same field being irradiated once in three or four days, according to the number of fields.

An overlapping of the field margins is only permissible if at least eight fields are used. For instance, if but six fields are used, the dose per field is 2,000 r for a total dose of 12,000 r. The areas of overlap will then receive more than 3,000 r, which is dangerous. If it is necessary to increase the dose above 12,000 r, it is advisable to increase the number of fields, to reduce the area of each and the total dose on each. The chances of overlap will then be reduced and should such overlap occur the danger is minimized.

The most serviceable fields are the iliac fossa, the lumbosacral regions, the gluteal regions and three or four median fields, one above the pubis, one vulval field, one perineal, and one sacrococcygeal field. We have on occasions added lateral fields when the patients presented a narrow pelvis and delicate bony structures, but these fields are not very efficient at tensions below 200 kv.

The integuments in the region of the anus, the vulva and the inguinal folds are more sensitive, the possibility of edema is here increased and in addition the phenomena of summation are found. These conditions lead us to reduce the size of the fields, irradiating these regions, that is, the median fields, and to reduce the dose on each field to 1,200 or 1,000 r. Thus, in the case of a patient weighing about 70 kg., we may have two symmetrical groups of three fields, each of 250 sq. cm., receiving 1,500 r each and four median fields each of 150 sq. cm. and receiving 1,000 r. This arrangement will permit a dose of 13,000 r without marked erythema during the course of the treatment and with no sequelae, neither early nor late, other than pigmentation. It is certainly desirable to avoid radioepidermitis for, with the large fields involved, late modifications of the vascular connective tissue may occur which result in a subcutaneous induration, and should this be infected serious skin lesions may follow.

The size of the fields will of course vary with the size and adiposity of the patients as well. In the case of patients weighing more than 70 kg. the maximum of 400 sq. cm. may be employed but in this connection the general effects due to the volume of tissue irradiated must not be forgotten. In the case of smaller patients, weighing

from 50 to 60 kg., it is better in any case to choose fields not exceeding 250 sq. cm. The upper limit of the fields should not rise above the level of the iliac crests.

Complications such as slight lesions of the heart, the lungs or the liver call for a reduction in the size of the fields and great prudence with the daily dose.

(*c*) *Depth Doses at the Site of the Lesion.* Under our working conditions the depth dose at the site of the lesion appears to vary between 20 and 40 per cent of the skin dose according to the size and weight of the patient. For those weighing over 70 kg., abundantly fat, this depth dose probably does not exceed 20 per cent, in thin patients it may reach 40 per cent. For the average patient weighing between 60 and 65 kg., it may be calculated that approximately one-third of the surface dose reaches the lesion. The dose necessary for sterilization of the lesion appears to lie between 3,000 and 4,000 r at the site of the lesion. It is therefore necessary in a case showing invasion of both parametria to give a surface dose of approximately 12,000 r for the average patient of 65 kg., a dose that may be reduced to 10,000 to 9,000 or even 8,000 r if the patient weighs considerably less. With the tension of 200 kv. at our disposal we have not been able to obtain satisfactory results without the association of radium when the patients have exceeded 70 kg.

(*d*) *The Rotation of Fields.* The same field should not be irradiated several times consecutively; the fields should be taken in rotation which results in a better protection of the skin and a better effect on the lesion. Thus, where both parametria are to be treated, the order may be: first, an anterior field on the right; second, a posterior field on the left; third, a median field so arranged that each field is irradiated but once in four days. The dose per seance on the anterior fields is usually kept a little below that on the posterior fields, partly because the tissues to be penetrated are less thick in front and partly because it sometimes happens that it is necessary to treat the anterior fields more frequently.

(*e*) *Direction of the Central Ray.* The central rays in the case of the iliac fields and the lumbosacral fields are directed obliquely towards a point 4 or 5 cm. lateral to the sagittal plane of the pelvis on the side of the field. This obliquity may reduce the dose received by the parametrium on the side of the irradiation a little in comparison with the energy it would receive from a vertical radiation cone, but the obliquity permits the simultaneous irradiation of the lesion in the midline and of the opposite parametrium. By this means a better utilization of the energy is obtained. With regard to the other fields the direction is determined by the extent and situation of the lesions whereby, in the case of the gluteal fields, considerable help may be derived from control by rectal examination.

(*f*) *Complications and Reactions.* These may be early or late, the first being due to excessive daily doses, the second to excessive total doses. The immediate complications are represented by the general reactions, the intestinal troubles and radio-epidermitis. All these ought to be avoided if possible. These difficulties are often found to follow the association of fields too large for the weight of the patient with excessive daily doses, in particular when the patients are debilitated or anemic. Thus, in a patient weighing 44 kg., we impute a fatal accident to intestinal derangement six weeks after the commencement of treatment with an excessive intensity of radiation.

In a few cases late cutaneous and subcutaneous lesions have been observed. They are represented by chronic induration of the subcutaneous tissues and by telangiectasis. These are liable to occur should a definite radio-epidermitis develop.

We have but seldom seen difficulties caused by the rectum and bladder when roentgen rays have been employed alone. In these cases symptoms of rectitis or of cystitis do not develop. In cases in which intracavital radium has followed the roentgen irradiation, it has not been very exceptional to meet with severe rectal and vesical reactions followed by sclerosis and stenosis of the rectum.

SUMMARY

Results. For the purpose of comparing the results of advances in technique during the period 1919–1929, we have considered three separate eras of treatment:

During the first period, to the end of 1922, there was no success among the patients treated for carcinoma of the cervix (Stage III and postoperative recurrences) by roentgen therapy whether or not this was combined with intracavital curie therapy.

During the second period, 1923–1927, roentgen therapy, either associated with intracavital curie therapy or alone, gave five year survivals among 70 Stage III cases and extensive operative recurrences of 28 per cent. For the Stage III cases alone the rate was 19 out of 60, or 30 per cent.

Since 1928 our collaborator, Baclesse, has taken special charge of these cases. For the third period, 1928–1929, the collected material has given a survival rate, for the Stage III cases alone, of 36 per cent.

Owing to the technical impossibility of employing intracavital curie therapy, roentgen rays alone were employed in certain advanced cases and there has been a gradual improvement in the results although they are very inferior to those obtained by the combined therapy.

Technique. During the period under discussion there has been a gradual development in the technique. At present we are using a tension of slightly less than 200 kv. maximum, a tube current of 5 ma., filter 2 mm. Cu, focus skin distance 70–90 cm., which gives an intensity of 3–5 r/min., measured on the skin.

The associated treatments have usually commenced with roentgen rays with radium subsequently, the doses being about 20 per cent larger when roentgen therapy is used alone. Except in the latter group the rays have been directed chiefly on the parametria.

The survivors in our material were found to have been given doses of from 10,000–12,000 r, the doses being varied according to the weight of the patient.

The duration of successful treatments was five weeks for 10,000 r, six weeks for 12,000 r, and seven weeks for 14,000 r, these figures being but approximate.

Fields are from 200–350 sq. cm., according to the weight of the patient. The daily dose, which is divided into two seances, one in the morning and one in the evening, starts at 250 r, increased after a few days to 300 r, subsequently to 400 r or even 500 r towards the end of treatment. There are eleven seances weekly.

General radiation effects such as fatigue, vertigo, sickness, tachycardia and local complications such as a reaction of the intestinal mucosa with diarrhea should be avoided. An increase in the daily dose is only possible when these effects are absent.

At least six fields are used. A dose of 2,000 r to each field will permit a total dose of 12,000 r without local reactions other than a slight pigmentation of the skin, with no marked erythema. With these doses, overlapping must be avoided for this would lead to excessive skin dosage in the order of 3,000 r. Rectal and vesical irritation is very rare in cases treated with roentgen rays alone but occurs occasionally with the combined treatments.

The following fields are chosen: two latero-sacrals, two ilio-inguinals and two gluteals, with additional median fields such as the suprapubic, vulval, perineal and coccygeal fields. The fields must be taken in rotation so that each field is irradiated but once in three or four days according to the number of fields.

Large fields, associated with high daily doses lead to serious complications when the patients are small. For a patient weighing 50 kilograms, the field is limited to 200 sq. cm., with daily doses not exceeding 300 r for a total dose of 7,000–8,000 r.

The total doses of 12,000–13,000 r are for the patients weighing 65–70 kg. when it is necessary to treat both parametria. If the disease is localized to but one parametrium, then total doses of 7,000–8,000 r will usually suffice. When the weight exceeds 70 kg. the treatment is usually well supported but, at 200 kv., seems often ineffective because of the insufficient dose at the site of the lesion, particularly if roentgen radiation is the sole therapeutic agent.

FURTHER OBSERVATIONS ON RADIATION THERAPY IN HYPERTHYROIDISM*

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DESPITE a voluminous literature on the subject, the value of radiation in the treatment of hyperthyroidism, and the indications for its use, are still debatable questions. This unsatisfactory status is due chiefly to the following factors: (1) lack of exact knowledge concerning the effect of irradiation upon the structure and function of the toxic thyroid; (2) difficulty in evaluating the effects of treatment because of the tendency of the disease to undergo spontaneous remissions, temporary or permanent; (3) confusion caused by adjuvant therapeutic agents such as iodine, sedation, rest, etc.; (4) lack of standardization of the dosage of radiation, and (5) the paucity of satisfactorily controlled and critical studies in the radiological literature.

In 1927, one of us reported before this Society indifferent results in a small selected group of cases treated by irradiation. Most of these cases had been followed only a short time. We now wish to report further observations on a group of 244 patients with hyperthyroidism, treated between January 1, 1926 and July 1, 1933, and to present certain conclusions concerning the use of irradiation in this disease.

The technique of treatment has varied during the period covered, but the method in use at present consists of two plans: first, a routine technique and second, a more intensive technique used in cases showing inadequate response to two or three series of the routine method. The technical factors used in the first plan are: 135 kv. (peak) (mechanical rectification); 5 ma.; skin target distance 30 cm.; filtration 0.25 mm. Cu, plus 1 mm. Al. These factors give an effective wave length of 0.23 Ångström units and half-value layer of 0.42 mm. Cu. The intensity per minute is 27 r (measured in air) and we consider 650 r as an erythema dose. One anterior portal measuring 195 sq. cm. is used and the larynx is protected from direct radiation. A dosage of 400 r (measured in air), which requires 14.8 minutes to administer, is given at one time and called a series. Occasionally a similar dose is given through a posterior portal one to seven days later. Three weeks usually elapse between each series.

With the second plan, the peak voltage is 165 (valve tube rectification with condensers); current 15 ma.; skin target distance 50 cm.; filtration 0.5 mm. Cu plus 2 mm. Al. These factors give an effective wave length of 0.17 Ångström units and the half-value layer is 0.88 mm. Cu. The intensity is 40 r per minute, measured in air, and we consider 800 r an erythema dose. An anterior portal measuring 225 sq. cm. is used, the larynx being protected from direct radiation. The total dosage is 600 r given in three equal amounts over a forty-eight hour interval. Such a series is given at intervals of four weeks and a total of eight erythema doses is never exceeded.

All patients were subjected to careful physical examinations before treatment was begun and at regular intervals during the follow-up period. Iodine was withheld during the period of irradiation in all but a few cases of recurrent postoperative hyperthyroidism.

The classification of therapeutic results is difficult in this disease. Recurrences are occasionally seen months or years after apparently complete recovery. Between the extremes of complete subjective or objective relief and complete failures, all grades

* From the Department of Roentgenology and the Endocrine Section of the Medical Clinic, Hospital of the University of Pennsylvania. Read at the Thirty-sixth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 24–27, 1935.

of partial improvement are encountered. For purposes of analysis we have divided our patients into eight groups:

A —those completely well, subjectively and objectively.

B_1—those almost completely well, but with slight residual abnormalities, such as slight elevation of basal metabolism, slight tachycardia, etc.

B_2—those showing marked improvement with economic restitution, but with definite residual abnormalities.

C —those who did not complete the prescribed course of treatment (this group is excluded from our analysis of results).

D_1—those successfully prepared for thyroidectomy.

D_2—those who could not be prepared for thyroidectomy.

E_1—complete failures.

E_2—those showing temporary improvement with ultimate failure.

For practical purposes, and to avoid undue complexity, Groups A, B_1, B_2 and D_1 may be considered as showing satisfactory results, and Groups D_2, E_1 and E_2 as showing unsatisfactory results.

Females predominated by about 4 to 1 (195 to 49). The majority of our patients (181) were between twenty and fifty years of age, 69 were in the fourth decade, and 61 in the third. The duration of symptoms ranged from a few weeks to two years or more; 115 had been ill for one year or less. Primary toxic diffuse goiter was the most common type, there being 179 cases and only 21 cases of primary toxic nodular goiter. There were 29 cases of recurrent toxic diffuse goiter and 2 cases of recurrent toxic nodular goiter following operative procedures. Three of the cases in our records were unclassified.

The following general types of response to treatment were observed: (1) a gradual progressive subjective and objective improvement; (2) apparent lack of effect over a prolonged period, with subsequent abrupt improvement or complete recovery; (3) temporary improvement with relapse; (4) prompt permanent remission; however, this is an uncommon type of response; (5) complete absence of response with steady increase in the intensity of the disease, and (6) a striking discontinuity in the proportionate relationship of the manifestations of the disease, subjective or objective, which we have elsewhere referred to as the "dispersion phenomenon." The patient improves in some respects and not in others. This is often especially striking in children, where tachycardia, for example, may persist long after the child is perfectly normal in all other respects.

Complications of treatment were few and unimportant. There was no mortality in this series, although we have since had one death from cardiac failure in a child of fourteen, while under treatment. Pigmentation of the skin and telangiectasis are occasionally seen. Nausea after treatment is uncommon. In a fair number of cases a temporary exacerbation of the thyrotoxicosis followed the first one or two exposures. Permanent hypothyroidism has not occurred. Reduction of the goiter and the exophthalmos cannot be consistently expected.

In considering our results it should be borne in mind that our patients represent in the main a carefully selected group, and were not treated in order just as they came into clinic or ward. Our results in general were as follows:

A	78 cases	D_1	3 cases
B_1	25 cases	D_2	7 cases
B_2	24 cases	E_1	49 cases
C	51 cases	E_2	7 cases

Deducting Group C from the total, satisfactory results (including those 3 cases successfully prepared for thyroidectomy by irradiation) were obtained in 67 per cent of 193 cases. There was no apparent relation between the number of series of treatments and the results. Likewise a study of the patients who failed to respond shows no distinguishing characteristic by which failure might be predicted in the future. There appears to be a definite relation between successive improvement in technique with increasing dosage and the percentage of satisfactory results—thus during the period 1926–1928 satisfactory results were noted in only 51 per cent, while during 1929–

1931, 68 per cent were satisfactorily treated, and during the period of 1932–1933, 90 per cent of the cases showed satisfactory improvement (Chart I).

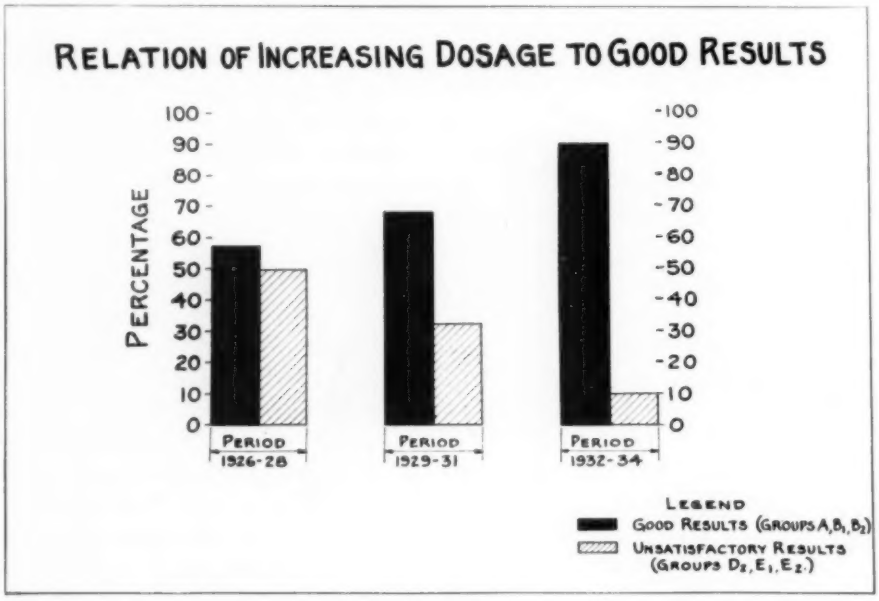

CHART I

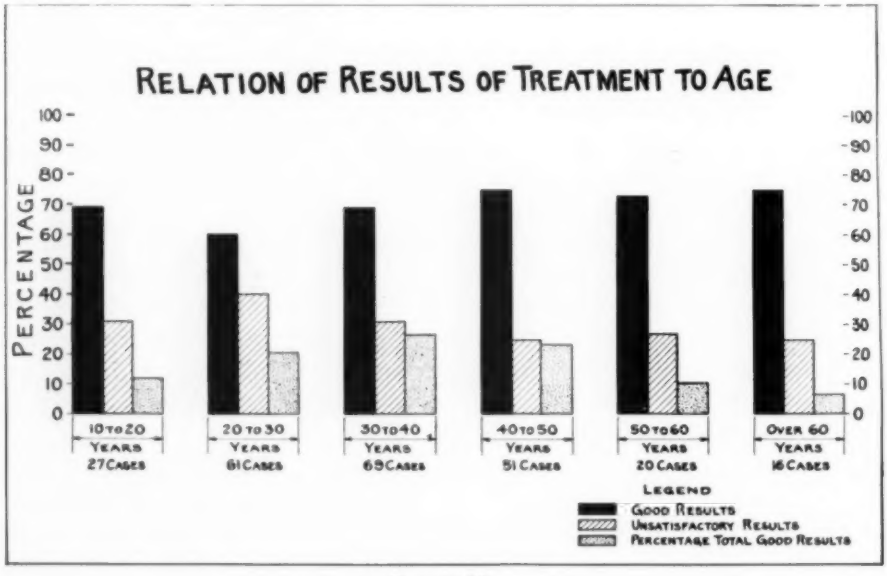
RELATION OF RESULTS OF TREATMENT TO AGE
PERCENTAGE
10 TO 20 YEARS 27 CASES
20 TO 30 YEARS 61 CASES
30 TO 40 YEARS 69 CASES
40 TO 50 YEARS 51 CASES
50 TO 60 YEARS 20 CASES
OVER 60 YEARS 16 CASES
LEGEND
GOOD RESULTS
UNSATISFACTORY RESULTS
PERCENTAGE TOTAL GOOD RESULTS

CHART II

A study of the good results, considering the age of the patients, shows that the highest incidence of satisfactory results (75 per cent) occurred in those patients in the fifth and seventh decades and the lowest (60 per cent) in the third decade. However, the greatest percentage of total good results (26 per cent) was found in patients in the fourth decade and the smallest (6 per cent) in the seventh (Chart II).

The highest incidence of satisfactory results (76 per cent) was found in those patients whose thyrotoxicosis had lasted over three years, although this group furnished only 10 per cent of the total good results. The lowest incidence of good results (63.8 per cent) was noted in those whose symptoms had lasted six to twelve months be-

fore treatment, though they comprised 20 per cent of total good results. Forty-six per cent of the total good results came from the group with symptoms dating back less than six months (Chart III).

eight per cent of the remaining 55 showed good results and these patients constitute 20 per cent of those satisfactorily treated. The highest incidence of good results (85 per cent) was noted in those followed one

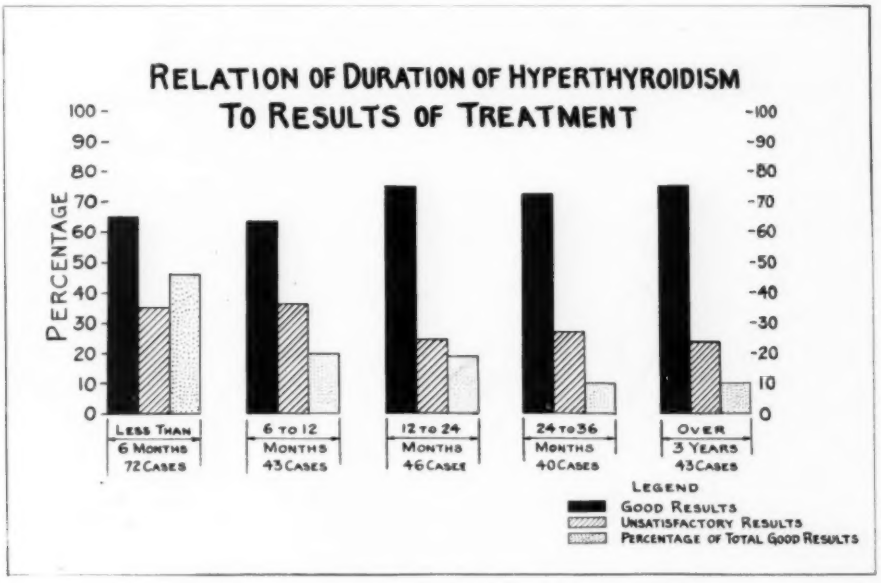

CHART III

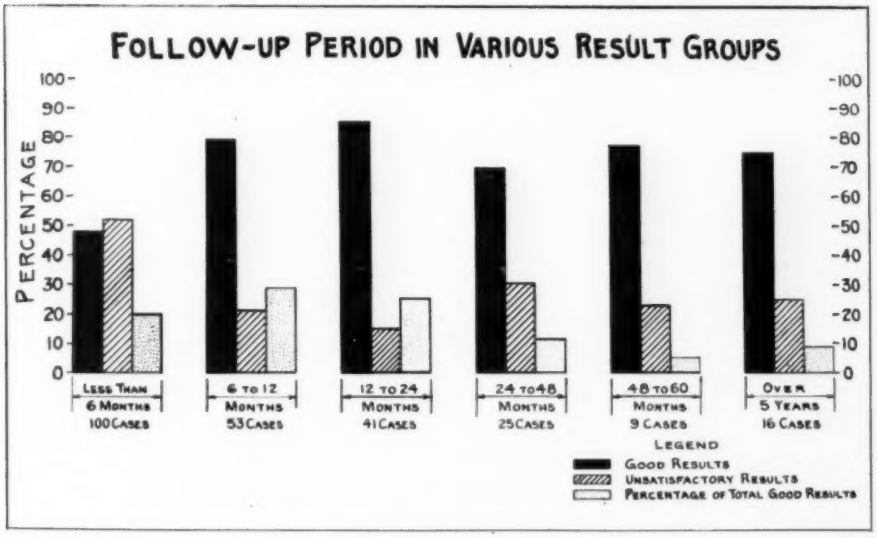

CHART IV

In evaluating end-results, the duration of the follow-up period of observation is important. The largest group of our cases has been followed less than six months. There were 100 patients in this group, including 45 who did not complete the prescribed course of treatment and were not included in the analysis of results. Forty-

to two years. Of the 16 patients followed more than five years, satisfactory results were noted in 75 per cent. The group followed six to twelve months furnished 28.8 per cent of our total good results; the group followed four to five years furnished only 5 per cent (Chart IV).

We have been very favorably impressed

by the effects of irradiation of diffuse toxic goiter in children below the age of fifteen and one of us has elsewhere analyzed a group of 10 such cases, most of whom are not included in the present series. Except for one recurrent postoperative case and one preventable death from heart failure, our results have been uniformly good. The dispersion phenomenon is prominent, and temporary partial phenomena of hypothyroidism are occasionally noted.

CONCLUSIONS

1. In unselected cases of hyperthyroidism, irradiation is probably inferior to expertly performed thyroidectomy as a therapeutic agent.

2. Irradiation possesses the advantages of (*a*) a negligible mortality; (*b*) no major complications; (*c*) low cost; (*d*) absence of physical and psychic shock, and (*e*) maintenance of the patients' earning capacity during treatment in most cases.

3. Its use is indicated in the following selected types of hyperthyroidism:

   a. All children and adolescents, except those with nodular goiters or visceral (i.e. cardiac) complications.
   b. Mild to moderately toxic adults without visceral complications or marked weight loss, who have a diffuse soft or elastic goiter; and with symptoms chiefly derived from sympathetic nervous system disturbances.
   c. Poor surgical risks.
   d. Patients who refuse operation.
   e. Patients with recurrent postoperative hyperthyroidism which cannot be controlled by iodization.

4. In the presence of progressive increase in the severity of the disease, irradiation should be abandoned and the patient prepared for thyroidectomy.

DISCUSSION

Dr. Edgar M. McPeak, Washington, D. C. The efficacy of irradiation in the treatment of hyperthyroidism is no longer a matter of conjecture. Reports of thousands of cases so treated are now on record and the results compare favorably with those of any other treatment of this disease. The results to be expected are approximately as follows: cures in 80 to 90 per cent; improvement in 10 to 15 per cent, and no change in 3 to 5 per cent.

Since the publication in the May, 1935, issue of *Radiology* of Borak's article on the "Treatment of hyperthyroidism by roentgen irradiation of the pituitary gland," we have instituted this in several of our refractory cases with satisfactory results. We believe the percentage of cures will probably be increased by including the pituitary fields in the routine areas treated.

There is no appreciable difference in the results obtained in the exophthalmic and adenomatous groups. There are no contraindications to this form of treatment. It is more economical than surgery and is free from the mortality attending that procedure. Some of the arguments advanced against radiation therapy by either the uninformed or those avoiding the facts are that sequelae, such as burns and telangiectasis, invariably follow this form of treatment and that unless these goiters are removed they are prone to become malignant.

We have not encountered a burn in the treatment of over 600 of these cases and the incidence of telangiectasis has been less than 2 per cent and most of these occurred in cases treated many years ago when knowledge of radiation therapy was somewhat meager.

It would therefore seem that the occurrence of telangiectasis in less than 2 per cent of the cases hardly constitutes a just condemnation of this method when compared to a surgical mortality of 1 to 3 per cent in the hands of the skilled, to 10 to 15 per cent in the hands of the less skilled, plus the hypothyroidisms, tetanies, nerve paralyses and disfiguring scars which occasionally occur.

As for malignancies developing in the thyroids treated by irradiation, this can be dismissed with the statement that we have never encountered nor have we seen reported such a case. Instead of being an argument against it, it should be an argument for it.

The successful management of hyperthyroidism depends upon more than irradiation or surgery. It involves a thorough medical study with the prescribing of a definite routine, such as diet, rest, iodine therapy, basal metabolic studies, removal of foci of infection and a thorough understanding of the difficulties involved. Unless this is carried out, either method is doomed to meet with more than its share of failures.

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FIVE YEAR CURE OF MAMMARY CARCINOMA WITH MULTIPLE METASTASES TO BONE*

By WRIGHT CLARKSON, M.D., *and* ALLEN BARKER, M.D.
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WHILE no very definite conclusions can be drawn from any one case, the recovery made by this patient treated by one of us (W. C.) five years ago, and the response we are obtaining from the same treatment in similar cases at the present time, seem to justify the detailed reporting of the first case and the outlining of our method of treatment, which appears to differ in some respects from that being given by other radiologists.

The first patient (Mrs. A. S.), aged forty-one, was referred by Dr. J. M. Williams of Petersburg, Virginia, on March 14, 1930. She was complaining chiefly of pain and swelling over the region of the fifth metacarpal bone of the right hand. A roentgenogram revealed a wide area of bone destruction which was interpreted as metastatic carcinoma of the osteolytic type.

FIG. 1*a*. Roentgenogram of right hand made March 14, 1930. Note the extensive bone destruction due to metastatic carcinoma in the fifth metacarpal bone.

FIG. 1*b*. Roentgenogram of same hand as shown in Figure 1*a*. This examination was made two years after treatment was begun. The bone has almost entirely regenerated.

On examination, a tumor was found in the left breast about 2.5 cm. above and external to the nipple. It measured approximately 5 cm. in diameter and was adherent to the overlying skin. The skin surface was dimpled at the point of attachment. The nipple was retracted and elevated above that of the opposite side and there were several lymph nodes measuring approximately 2 cm. in diameter located in the

* Read at the Thirty-sixth Annual Meeting, American Roentgen Ray Society, Atlantic City, N.J., Sept. 24–27, 1935.

corresponding axilla. The patient stated that the enlargement in the breast was first noticed in December, 1928. It was described as being about 1 cm. in size when first discovered. Her attention was called to it by pain in this region.

Examination of the right foot revealed a distinct enlargement of the distal phalanx of the middle toe. The patient stated that this swelling had begun, accompanied by pain, about nine months after the lump appeared in her breast. There was also pain in the region of the right hip joint and in her back to the right of midline about the eighth rib, appearing at about the same time as the pain and enlargement in the toe.

FIG. 2*a*. Roentgenogram showing bone destruction in distal phalanx of toe. This was amputated for examination.

Additional roentgenograms were made to include practically the entire body. These showed metastases in the phalanx of the toe described above, in the upper end of the right femur, in the right half of the bony pelvis and in the eighth rib on the right side about 5 cm. from its attachment to the spine. There was also one tiny cyst-like area in the lower end of the right humerus and there were several suspicious areas in the distal phalanx of the great toe of the right foot.

Examination of the patient's mouth showed a severe pyorrhea. The Wassermann reaction and other laboratory examinations were negative except for evidence of a moderately severe secondary anemia. The patient was thin and emaciated in appearance, weighing 95 pounds, and stating that she had lost about 10 pounds in weight during the previous six months. The past history was essentially negative except for an appendectomy performed in 1916 and a tonsillectomy in 1918. She began menstruating at the age of fifteen, always regular; married in 1929; she was never pregnant.

After preliminary irradiation the distal phalanx of the involved toe was amputated and the tissue has subsequently been examined by several eminent pathologists who agree that the bone shows metastatic carcinoma, probably from a scirrhous carcinoma of the breast.

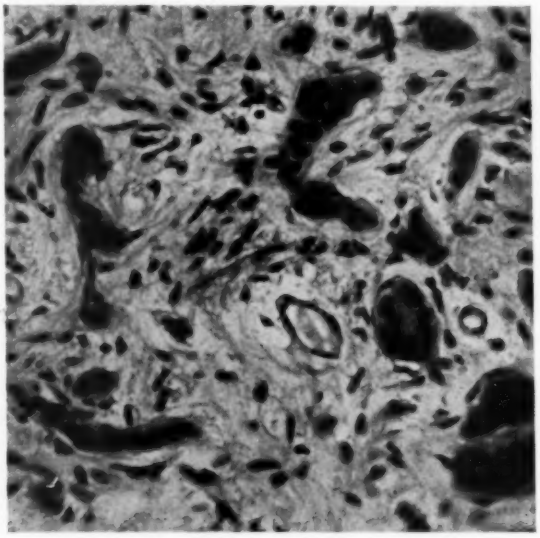

FIG. 2*b*. Photomicrograph of the tissue removed from distal phalanx of toe shown in Figure 2*a*.

The reports in the literature as to the value of irradiation in metastatic carcinoma were so conflicting up to that time and cases previously treated had responded so poorly, that it was decided to change the method of procedure in this case. The patient and her husband were given the facts and both expressed their willingness to cooperate.

In view of the embryonal nature of all cancer tissue and in view of the fact that the gonads are chiefly responsible for the production of embryonal cells in the body, it was decided to treat these and also certain other glands that might have some influence on embryonal tissue.

Previous cases had shown that the control of any one bone metastasis was relatively easy, but that other metastases were apt to appear in other parts of the body, and that each new lesion treated always proved to be a little

more radioresistant than the previous one treated in the same patient. It was, therefore, decided in this case to expose the whole body to irradiation, and to do so from the beginning.

The patient's consent to sufficient irradiation over the ovaries to produce an immediate artificial menopause was obtained, and the ovaries and left breast received more irradiation than any other parts of the body, as evidenced by the fact that no telangiectasis can now be found except upon the skin overlying these areas. A total of approximately 2,600 r was directed towards the ovaries, in addition to the amount received by them during the general body irradiation.

The pituitary, thyroid, thymic and each adrenal area were given approximately 800 r, in addition to the amount received during the irradiation to the whole body.

A total of 2,400 r was directed towards the metastases in the right half of the bony pelvis and proximal end of right femur; 2,000 r to the fifth metacarpal bone of the right hand; 3,700 r to the affected breast and 2,100 r to the metastasis in the eighth rib. In addition to the above, 14,000 r was given to the body as a whole. This amount of irradiation was as equally distributed as possible, care being taken to irradiate every inch of the body surface. The liver received about 50 per cent less irradiation than the remainder of the body and this lesser amount was given in small doses over a longer period of time. The cranium also was given about 50 per cent less irradiation in the effort to save the patient's hair. Treatment to this part was effected largely through the neck and face since repeated roentgenograms showed no metastases to the skull.

The factors used for the general body treatments were as follows: 200 kv., 4 ma., 80 cm. distance, and 0.5 mm. copper and 1 mm. aluminum as filter. These were given through a 5×50 cm. opening in a lead diaphragm placed 5 cm. above the patient. The field was sufficient to cover the entire width of the patient's body, including the arms, and the table upon which the patient was lying was moved gradually so as to distribute the radiation evenly from one

Fig. 3*a*. Roentgenogram of right hip made March 17, 1930. Note the areas of metastatic carcinoma in the neck of the femur, in the greater trochanter, and along the lateral margin of the ilium.

Fig. 3*b*. Roentgenogram of the same hip as shown in Figure 3*a*. This examination was made August 11, 1935, more than five years after treatment was begun. Note that the bone has returned to practically normal texture.

end of the patient to the other. The same voltage, milliamperage and filter with a distance of 50 cm. and fields of approximately 200 sq. cm. were used in treating the right half of the bony pelvis and other thick parts; 132 kv., 4 ma., 25 cm. distance, 4 mm. of aluminum and fields of approximately 100 sq. cm. were used for treating thin areas such as the toe and hand.

The interval between treatments at the beginning was two days, but this varied later according to the blood findings and the general reaction of the patient. The average total duration of the treatments during one day was thirty minutes.

The first treatment was given on March 17, 1930. All of the treatments directed specifically to the ovaries and other endocrine glands, approximately 50 per cent of the total radiation directed to the left breast and specified metastases, and about 20 per cent of the total irradiation given to the body as a whole, were delivered during the first sixty days; 75 per cent of the total radiation of all kinds received by the patient was delivered during the first six months. The balance was spread over a period of one year in the hope of keeping up the saturation, somewhat as suggested by Regaud,[1] Kingery[2] and Pfahler,[3] though over a longer period of time.

Since there were so many metastases, the breast was not amputated in this case. Parenthetically, it should be added that in all subsequent cases we have advocated the removal of the primary lesion, particularly in cases where the metastases were of short duration.

The above case, with full details of the treatment, was first reported as part of a symposium on neoplastic diseases given by Dr. Joseph C. Bloodgood before a regular meeting of the Post-Graduate Medical Society of Southern Virginia, at Petersburg, Virginia, on May 13, 1931. The patient was demonstrated as a part of the clinic held at this meeting. Since that time, the case has been reported several times before various medical associations, including the Medical Society of Virginia. Though no claim of a permanent cure is here made the above facts seem worth recording. It should also be stated that a physical examination has been made recently, including roentgenograms of practically the entire body of the patient, and no evidence of cancer has been found. The bones previously involved have returned to practically normal bone texture, the patient weighs 19 pounds more than she did when treatment was begun more than five years ago, and she is apparently enjoying good health.

As our knowledge of endocrines becomes more complete, we may learn which of the glands should receive particular attention. At present, we feel that intense irradiation of the gonads is most important, and we doubt that any real good was accomplished by the relatively small amounts of radiation given specifically to the other endocrine glands in this first case.

In view of the uncertainty as to the effect of general body irradiation upon the health of a patient, only 3 of our cases were treated in this manner up to about two years ago. The treatment of all three of these was begun in the spring of 1930. The other 2 had no bone involvement and will be reported in detail elsewhere. It will suffice to say that one was a case of lymphosarcoma involving the lymph nodes of practically the entire body. The other was a case of carcinoma recurrent in the lymph nodes following radical amputation of the breast for carcinoma. All of these cases are clinically well today.

The cases treated by us recently are apparently doing well but sufficient time has not elapsed to justify definite conclusions.

While Dessauer exposed the entire body to irradiation as early as 1905, only a very small number of radiologists seem to have used this method. In treating cancer anywhere in the body one should remember that death rarely results from a direct extension of the growth but usually from the metastases, and since the presence of these cannot always be detected, it seems logical to irradiate the entire body in every case where it is reasonable to suspect that the growth may have metastasized beyond the local area.

While we are convinced that the liver

will tolerate more irradiation than is generally believed, the treatment over this area should be begun with very small doses and repeated examinations of the blood should be made. On several occasions, in dealing with advanced cases, so much reaction followed irradiation of the liver and endocrine glands as to necessitate blood transfusions. In such cases mixed gland extracts were also given in an effort to resuscitate the patients. The liver appears to have considerable recuperative power if not damaged too severely. If the patient suffers from too much nausea and vomiting or develops considerable anemia, the liver should be protected for a time or not treated at all until the patient regains strength. We have found injections of liver extract and the administration of bile salts and viosterol to be helpful in these cases.

When all of the patient's bones are included in the general body irradiation, it is imperative for blood examinations to be made at frequent intervals. The number of blood platelets and the total number of leukocytes in the peripheral circulation will continue to decrease for six or eight weeks after the irradiation has been discontinued. The blood-forming organs of the young seem to be more sensitive to the treatment than those of older people. All patients so treated, however, begin eventually to complain of "blue spots" which occur on various parts of the body. These look like bruises and they are often the first sign of danger. These subcutaneous blood extravasations occur wherever there is the slightest trauma. They begin to appear when the blood platelet count reaches a level of about 120,000. At the same time, the total leukocyte count is usually found to be about 3,500 and the differential count will show the polymorphonuclear leukocytes considerably below normal in percentage. Irradiation should be discontinued, at least temporarily, soon after this stage is reached, otherwise the patient will soon develop hematoma and hemorrhages will occur from the various mucous membranes of the body.

Six weeks after the discontinuance of the radiation treatment of one of our recent patients, the blood count reached the following levels: total leukocytes 1,400; polymorphonuclears 61 per cent; lymphocytes 35 per cent; eosinophiles 1 per cent; large mononuclears 3 per cent; total red count 2,440,000; hemoglobin 40 per cent. The red cells showed a slight variation in size and shape and an occasional red cell showed polychromatophilia. The patient was extremely weak and desperately ill for a few weeks, but four months later the blood count had returned to the following levels: total leukocytes 4,200; polymorphonuclears 74 per cent; lymphocytes 22 per cent; large mononuclears 4 per cent; total red count 3,420,000; hemoglobin 61 per cent. At the same time the chemical analysis of this patient's blood was as follows: total serum protein 7.8 per cent; albumin 4.4 per cent; globulin 3.4 per cent; phosphates, inorganic 0.75 mg. per 100 c.c. of blood; calcium 10.2 mg. per 100 c.c. of blood and non-protein nitrogen 27.0 mg. per 100 c.c. of blood.

We are treating our present cases similarly to the first cases treated five years ago, except that the time interval over which the irradiation is given has been shortened as far as practicable, and that in addition to the roentgen irradiation, interstitial irradiation is used where indicated.

SUMMARY

1. A report is given of a case of mammary carcinoma, with multiple osteolytic metastases to bone, in which the patient has remained clinically well following irradiation for a period of five years and the involved bones have returned to practically normal bone texture as revealed in the roentgenograms. Two other cases are also reported. They received the same treatment five years ago and are clinically well. One was a case of lymphosarcoma involving chiefly the superficial lymph nodes and the other was a case of carcinoma of the breast recurring in the lymph nodes following a radical breast amputation.

2. The treatment consisted of exposing the gonads to sufficient irradiation to produce permanent sterilization, irradiating intensely all known areas of malignancy, and subsequently irradiating the entire body at frequent intervals over a period of months.

3. The above line of procedure is recommended in treating all types of malignancy where the growth has metastasized widely to the patient's body.

4. It is suggested that the liver will tolerate more irradiation than has hitherto been advocated, but the treatment of this organ should be begun by the administration of small doses and a careful watch should be kept for unfavorable reactions.

5. While the method here recommended is not expected to prove a panacea for the treatment of cancer, and while no claim is made of a permanent cure in these cases, and while the full value of the procedure must await further experimentation, it is believed that the combination method here described will at least save an occasional case that otherwise would succumb to the disease.

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DISCUSSION

Dr. J. H. Vastine, Philadelphia. The presentation by Dr. Clarkson and Dr. Barker was most interesting. Results of this kind are almost miraculous. One cannot help but be impressed by the relation of the endocrine secretions to mammary carcinoma. Lacassagne has produced carcinoma of the breast in both male and female mice by the administration of folliculin in large doses. Dresser and others have demonstrated the regression of skeletal metastases following irradiation of the ovaries. Martin has comprehensively reviewed this subject. Interruption of ovarian function in women in the premenopausal age undoubtedly plays an important rôle in regression of metastatic malignancy to the bones. That irradiation in addition exerts a direct influence upon the malignant cell or its environment is suggested by numerous cases which we have seen.

CASE I. Miss L. K., aged thirty-nine. Patient admitted to the Women's College Hospital on November 13, 1932. She had had a breast amputation two years previous to admission. A year and a half prior to admission she developed pain in the legs and back which had interfered with the carrying on of her duties as a school teacher. When first seen she was unable to walk or stand and was moved with considerable difficulty and suffering. She was treated over the lumbar spine, pelvis and upper femora with such relief that she resumed her duties as a teacher in several months and has continued in that capacity ever since except for occasional short intervals when she came to Philadelphia for treatment. In November, 1934, she complained of pain in the right chest posteriorly and a roentgenogram revealed metastases to the ribs and within the lung. Treatment over the chest was followed by recalcification of the affected ribs and a diminution in size of the pulmonary metastases.

There are certain factors to be considered in this case. She was a young woman in the premenstrual phase. She was treated over the pelvis resulting in cessation of her menses. According to the recent literature, the effect on the ovaries, probably stopping the excretion of folliculin is partially responsible for the favorable response. That it is not the only factor is evidenced by the appearance of metastases in the ribs and lungs a year and a half after interruption of the ovarian function. A recalcification of the costal metastases and decrease in the pulmonary metastases followed direct irradiation to the chest. These metastases became apparent two years after the ovaries had been thoroughly irradiated and only recalcified and decreased after direct exposure of the lesions.

CASE II. Mrs. A. B., aged thirty-two. When first seen by Dr. Pfahler in 1913, she had postoperative recurrences following a radical amputation of the right breast. Roentgenograms showed involvement of the ribs. These recalcified following direct irradiation of the lesions. No irradiation was given over the pelvis and the menstrual cycle was not interrupted. The argument had been advanced that in some cases an osteolytic process precedes an osteogenic process and that this osteogenic process occurs spontaneously without other help or interference. This is probably true, but the clinical improvement and recalcification can be so closely correlated with the

institution of radiation therapy in these cases that the possibility of spontaneous regression is remote.

Case III. Mrs. M. Mc., aged forty-seven, was first seen in 1925 with metastatic malignancy to the 7th cervical vertebra from a carcinoma of the right breast. Treatment was given locally with subsequent recalcification with a complete relief of symptoms. She had had a tumor of the breast for ten years and had neck symptoms for several years. Within six months there was a complete recalcification which followed direct irradiation of the lesion—the ovaries were not irradiated.

Time does not permit presentation of further cases some of which were treated by irradiation over the metastatic lesion alone and others in which the ovaries were included in the irradiated fields. The longest survival observed by us was six years of symptomatic relief following irradiation for metastatic carcinoma to bone.

When one can show such a definite response with sustained relief in advanced carcinoma which has *metastasized to bone*, as Dr. Clarkson has just done, and as the above cases illustrate, one need not attempt to prove statistically the value of irradiation in the treatment of carcinoma of the breast. The subject can no longer be regarded as controversial. If irradiation is effective in advanced carcinoma, it must be inferred that it is of value, at least as a preoperative or postoperative measure, in early carcinoma of the breast.

Dr. Clarkson (closing). The kind remarks of Dr. Vastine and others relative to our presentation are sincerely appreciated. When I undertook this experimental work more than five years ago, comparatively little was known about the relationship of endocrines to the growth of neoplasms, and the treatment given in these cases was based largely on clinical observation. Since that time, more knowledge of the subject has been gained through the efforts of our most eminent research workers, and as a result thereof we may be able further to perfect our treatment in the future.

MODIFICATION OF THE BIOLOGICAL EFFECTS OF RADON BY ALTERATION OF FILTRATION

A STUDY IN RADIONECROSIS

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EXPERIENCE with the scars produced by lightly filtered roentgen rays (filter 0.5 mm. of aluminum with 0.5 mm. of copper) and radium rays (0.5 mm. platinum filter) in the radiotherapeutic clinic of the Royal Melbourne Hospital, in common with many other centers, has revealed that, in comparison with the more supple, less exfoliative scars of more heavily filtered rays (2 mm. Cu for roentgen rays and 0.8 mm. Pt for radium needles of 1 mg. element per cm.), a greater number of those scars undergo a necrosis some time after the initial irradiation. In the case of radium scars the most usual interval is two to three years; in roentgen scars a period up to ten years or more may elapse.

The literature on the modification of effect by filtration contains references mainly to physical investigations of the emergent radiation, but these are limited by lack of discrimination of the instruments used for the evaluations made (Failla[1]). This was so marked that in the present investigation no absolutely accurate guide could be obtained from any of this literature as to just what rays were being used, but a general guide could be found. Details of this will be given in the experimental section of this paper. On the biological side no very direct evidence of variation of reaction has been demonstrated. Usually simple, most often unicellular organisms have been used. The nearest approach to an investigation of the present problem is that by Benner and Snellman[2] but the duration of their experiments was too short to bring out the more remote effects of varied screenage in relation to tissue reactions. By discounting implantation experiments, and relying on surface application, they came to the conclusion that the secondary radiation from metals of high atomic number has a greater biological effect than that from those with lower numbers.

The problem of delayed radionecrosis has been attacked previously also by histological investigation of human material after necrosis has taken place (bibliography in ref. 3). In most instances the actual mechanism of the necrosis has been attributed to a vascular blockage the result of endarteritis. Since this microscopic finding cannot be accepted as conclusive evidence of a reduction of the flow of arterial blood so great that actual necrosis of the fibrous tissues and epithelium of the area would take place, it was decided to investigate the problem along the following lines.

(1) The results of histological investigation of human material have been published.[3] This revealed no very significant new facts except that very little evidence of endarteritis obliterans was found and that quite close to the areas of death of connective tissues apparently normal vessels were found. The same changes in the character of the epithelial and connective tissues as had been previously described were found.

(2) The vascular reaction in the tissue irradiated by interstitial implantation of radium was investigated by repeated observation of the surface temperature. At the time of writing an insufficient number of observations has been made for sound conclusions to be drawn. It is apparent (Chart 1), however, that for the first two years an increased surface temperature is present which is succeeded in some cases by a lowered surface temperature up to four years after irradiation. Few cases have been treated longer than this but those investigated show a normal surface

temperature. Though one cannot define any hard and fast relation between surface temperature and vascularity, it would appear to be a sound inference that an increased surface temperature indicates hyperemia and that a reduced surface temperature indicates relative ischemia.

These observations have not been made relative to the problem of varied filtration of radiation but in relation to radionecrosis in general. They are given here to indicate the length of time during which there is evidence of change in the irradiated area and, in conjunction with the clinical evidence of onset two or three years after irradiation of late radium necrosis, made it apparent that experiments on animals should be of long duration. Also these two independent observations mutually confirm the period of lowest anabolism, as judged by tissue death and reduced blood flow respectively, in the area, and provide a criterion of time in the human for comparison with that at which necrosis occurred in the experimental animals.

(3) Interstitial irradiation of animal tissues was carried out and some animals were killed at intervals to allow a study of the tissue reactions at stated time intervals.

DETAILS OF EXPERIMENTAL PROCEDURE AND FINDINGS

Dogs free of scars and skin disease were used. Under chloroform anesthesia con-

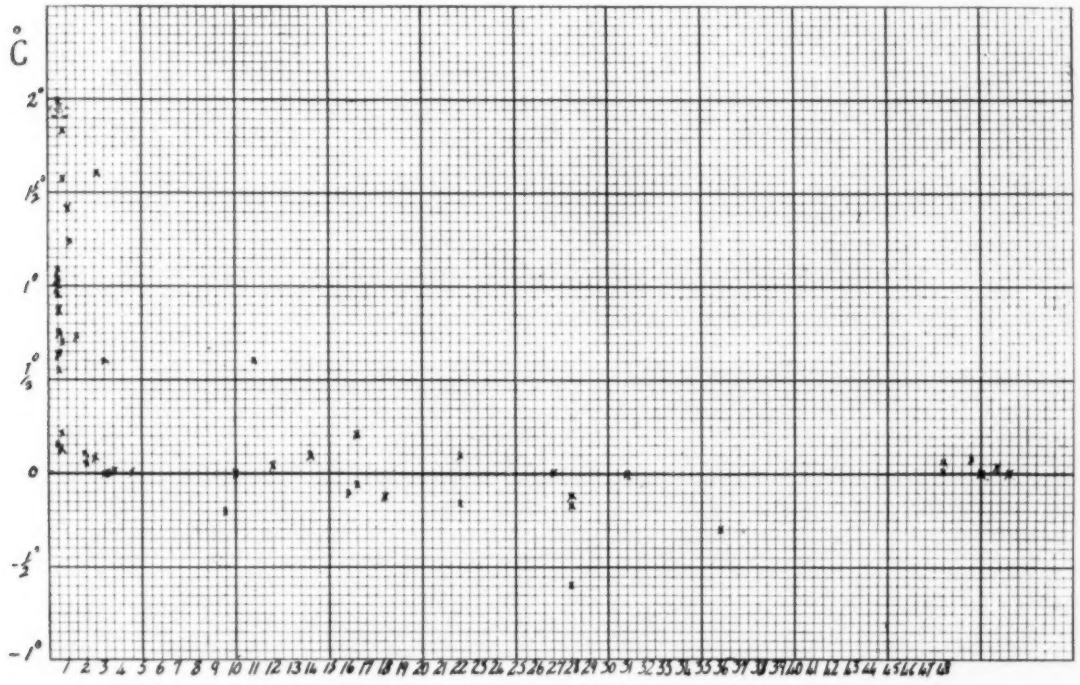


Chart I. Surface temperature of irradiated areas on the face of humans compared with symmetrical normal area. The patients were seated in a draughtless room with the whole face exposed for ten minutes before observations were made. The difference in °C. (ordinate) between the two areas was then plotted in relation to time elapsed in months (abscissa) since irradiation.

tainers were implanted in the soft tissues of the upper and lower face, at the level of the buccal reflection of mucosa but were introduced through the skin and lay nearer the skin than the mucosa of the mouth. Another container was implanted in the subcutaneous tissues of the foreleg and another container into an area over the rump. If the usual method of anchoring the thread at the site of container puncture is used, many of the containers are displaced by the animal. It is better to anchor the container by threading a straight needle on to the anchoring linen, pass this along the proposed site for the container and

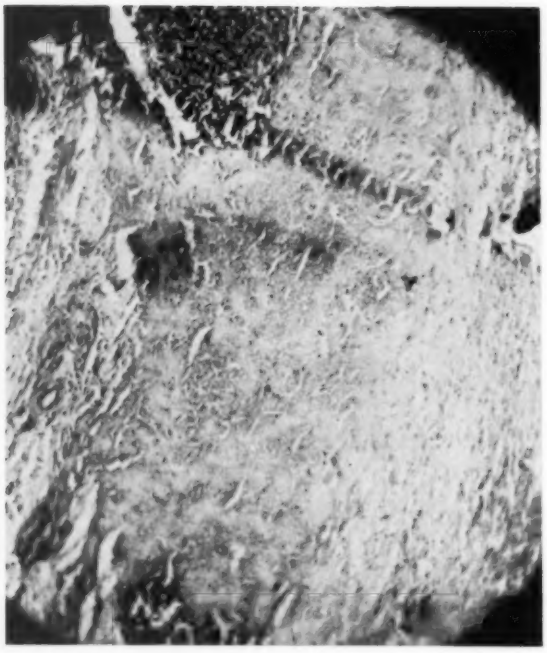


FIG. 1. Section of left lower lip* of Dog No. 2 irradiated one month previously. ×120. A small collection of leukocytes is present in the needle track and surrounding it is an area of hyalinization of the connective tissues. This area is peculiar in that hyalinization is not uniformly distributed around the needle.

* Left side: heavy filtration. Right side: light filtration.

through the skin. The radon container is now drawn along this track; about 1 cm. of the thread is left between the skin and the end of the container. The surface end is anchored by a locking stitch. It was found that if the area was left uncovered the toilet by the dog kept the puncture wound quite clean with little or no pyogenic reaction, whereas if it were covered up with gauze and adhesive strapping a marked purulent inflammation almost invariably occurred.

The source of radiation was radon prepared by the Commonwealth Government Radium Laboratory at the University of Melbourne. This was used because of cheapness, as in animal experiments loss of a container occasionally occurs. This was enclosed in sealed gold capillary tubes of 0.375 mm. wall and 2.5 cm. length. The containers implanted in the right side of the dog were further enclosed in a nickel tube to make the total filter equivalent to 0.55 mm. of platinum. The content of these was 4.83 millicuries. For the needles in the left side, the capillary tubes were enclosed in a gold tube which made the total filtration equivalent to 0.8 mm. of platinum. The content of these was 5 mc. which insured that the emergent primary γ radiation from the two types of container was equal. The containers were left in position for six days exactly and then removed. This time interval was used as the upper limit of tolerance of the dog's tissues. The animal was then kept under clean conditions with adequate food and sunlight. Sufficient room for exercise was not available but they kept in good condition throughout the experiment.

The primary γ radiation from each needle was of the same magnitude. The quality was different. More of the soft primary γ rays from the radon emerge from the less highly filtered container. From the needle with 0.3 mm. gold made to 0.55 mm. platinum with nickel (atomic number 28), there is a much softer secondary β and γ radiation than from the gold enclosed tube

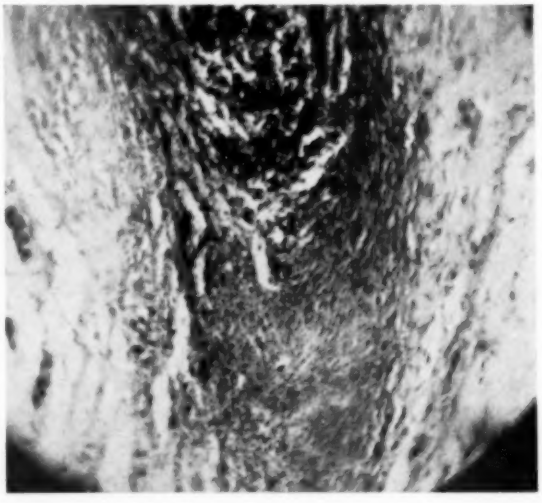


FIG. 2. Section of right lower lip of Dog No. 2 irradiated one month previously. ×120. There is a larger area of lumen infiltrated with leukocytes than on the left side. A zone of avascular fibrous tissue hyperplasia is present but hyalinization is less marked than on the left side.

(atomic number 79). The wave length of the secondary γ radiation of the K series from nickel is about 1.65 Å, that from gold about 0.190 Å. By using the needles singly, any scattering by the metal covering of radiation from other sources is obviated.

When the needles were removed the skin was moist over each container, epilation and ulceration over similar areas on each side took place at ten to sixteen days from commencement of irradiation, and healing was complete in six weeks showing a central area 3×1.5 cm. approximately of whitened scar with no hair, surrounded by 2–4 mm. of epilated pigmented skin with papillation still present. No constant variation between the two sides was present throughout the series.

Number	*Time after Irradiation*	*Condition Found in Scars*
1	1 month	All eight areas show active fibrous tissue reaction with almost complete closing of puncture. No definite evidence of difference between the two sides was found.
2	1 month	The areas on the fore and hind legs show similar microscopic findings but with more necrotic tissue infiltrated with leukocytes around the area of the needles on the right side than the left but a wider zone of hyalinization of the collagen on the left than the right side. On the right side there is also a well-marked fibrous tissue hyperplasia without vascular change surrounding the necrotic area which was not seen on the left side (Figs. 1 and 2). This was more marked around the face needles.
3 and 4	2 months	On the right side the area of periacicular granulation tissue has become vascularized and is larger than in the case of Dog No. 2. The site of the needle is obliterated by this growth of granulation tissue (Fig. 3). On the left side no marked granulation tissue is apparent. The previously noted periacicular reaction is in about the same stage as formerly but the necrotic area has disappeared and the nuclei in the hyalinized areas have a more normal appearance.
5	3 months	The periacicular reactions on the two sides show reactions which are most markedly different in the lower jaw areas. On the left side the periacicular reaction shows little more than 1 mm. diameter of hyaline tissue with a surrounding collagen of increased density of fiber. On the right side there is an area about 3 mm. in diameter of a more active fi-

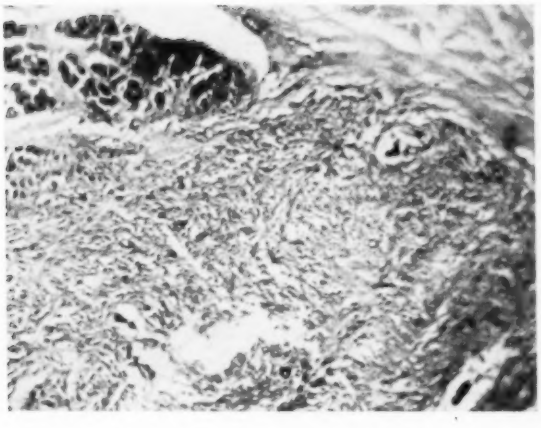


Fig. 3. Periacicular reaction of tissues in right foreleg of Dog No. 4 irradiated two months previously. ×120. Avascular granulation tissue is present in the area. Corresponding to the avascular reactionary tissue in Figure 2.

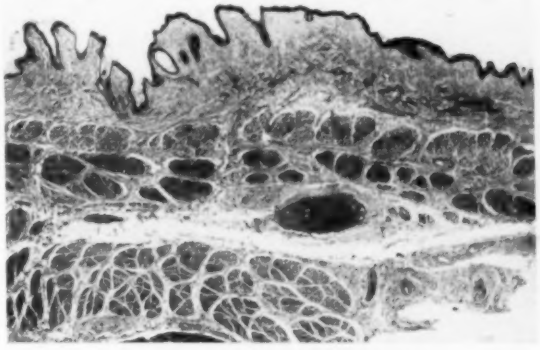


Fig. 4. Section of left lower jaw of Dog No. 5 irradiated three months previously. ×10. Epilation and hyalinizing of general connective tissue is present. In the region of the needle there is a small area of hyaline fibrous tissue. The vessels in the neighborhood show no evidence of obliteration.

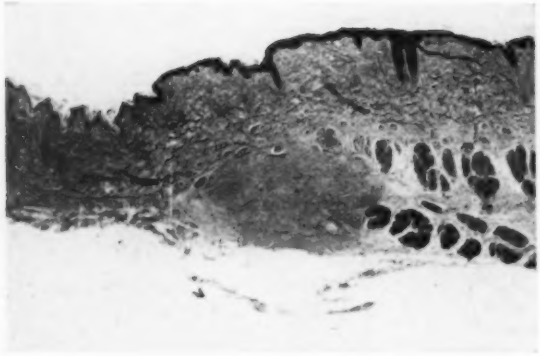


FIG. 5. Section of right lower lip of Dog No. 5 irradiated three months previously. ×10. Epilation and hyalinization of the general connective tissue is present. A zone of fibrifying granulation occupies the previous site of the needle. Infiltration of the degenerated muscle tissue by fibrous tissue is much more obvious than on the left side.

brous tissue than on the left side and presenting a greater infiltration of muscle tissue of the jaw. In the other areas of this dog a much less marked difference was present (Figs. 4 and 5).

6	$3\frac{1}{2}$ months	Changes similar to but with less marked differences than in Dog No. 5 were found. On the forelegs, however, the right side showed a diffuse excessive collagen and elastic tissue formation over a width of about 0.5 cm. of the scar whereas the left side showed an even change in the tissues throughout the scar (Figs. 6 and 7).

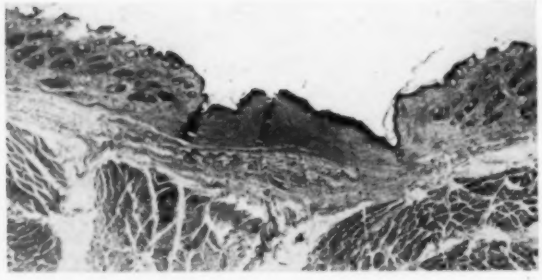


FIG. 7. Section of right foreleg of Dog No. 6 irradiated three and a half months previously. ×8. Epilation and hyalinization of the tissues surrounding are seen. In the periacicular zone a diffuse advanced hyalinization of the tissues is present in a depressed scar.

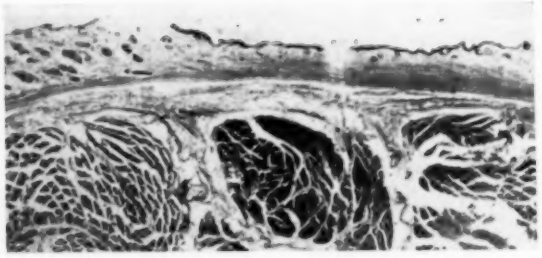


FIG. 6. Section of left foreleg of Dog No. 6 irradiated three and one-half months previously. ×8. Epilation is seen together with hyalinization of the connective tissue with no periacicular zone.

7 and 8	4 months	Changes similar to Dog No. 5 and 6 were found but with more hyalinization of the periacicular tissue on the right side than previously and the differences between the two sides not so marked as in previous illustrations but, as in Dog No. 6, the periacicular reaction on the left side was not discernible.
9	5 months	The scars on the left side present an even change in the tissues, the periacicular reaction being negligible but that on the right lower lip shows a dense hyalinization of the periacicular reaction which is almost anuclear, shows fine granules of material taking

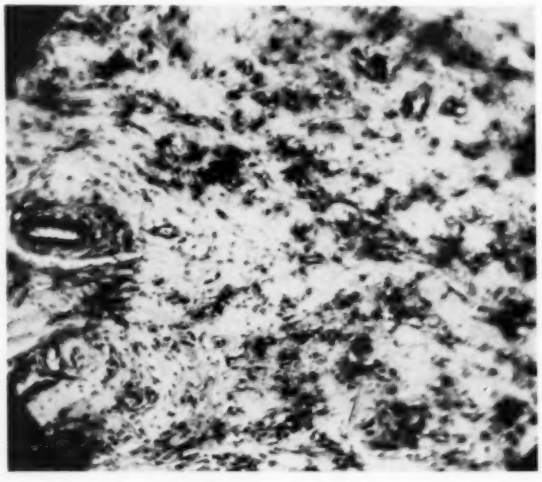
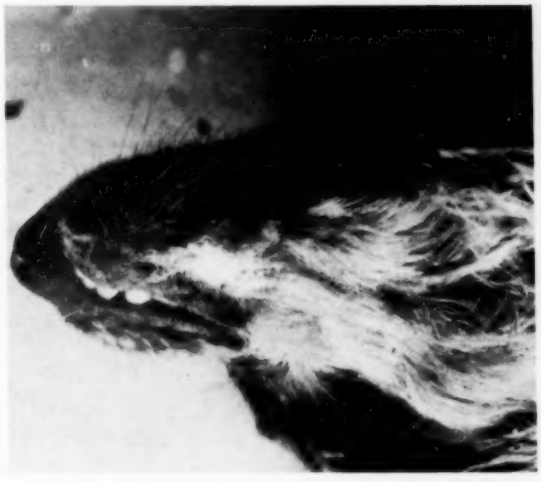


FIG. 8. Section of right lower lip of Dog No. 9 irradiated five months previously. ×120. The periacicular zone is shown as hyaline tissue with small number of nuclei and vessels. Scattered through it are fine granules taking the hematoxylin stain.



Figs. 9 and 10. Photographs of left and right lower face lesions of Dog No. 10 irradiated six months previously. The scar on the left side is the more supple as judged by the wrinkling which is present.

the hematoxylin stain, possibly calcium, but vessels are still apparent in the tissue (Fig. 8). On the upper lip and the legs the areas are less marked and more cellular than that on the lower lip.

10 6 months The areas on the legs present the same appearance as the previous dog. The areas on the lower face show approximately the same areas of epilation and whitened skin as may be seen in Figures 9 and 10, but that on the left side is more supple as may be judged from the wrinkling which has taken place during fixation. On section the area of hyaline tissue on the right side was found to have become necrotic (Fig. 11). Small remnants of the hyaline tissue can be found around the edge of the necrotic area and the piece represented shows what may be considered to be an adequate vasculature. On the upper face there was present on the right side a small punched-out necrotic area in the center of the scar. On section a necrosis more advanced than that in the lower jaw is present. The degeneration of the hyaline tissue is not complete (Fig. 12), but the necrotic area has broken the surface.

11 7 months The areas on the upper face and legs show a slightly greater amount of hyaline tissue at the center of the scars on the right side than on the left side. At six months, however, the right lower face area became ulcerated in the center. Trauma may have occurred but no appearances of it were present. This ulcer was punched out and extended almost to the mandible. It

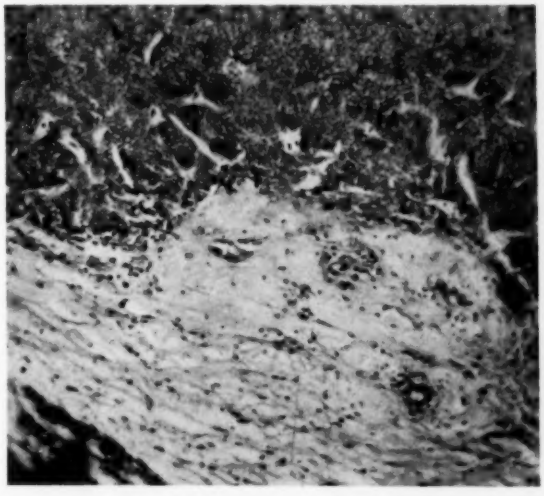


Fig. 11. Section of tissue in periacicular zone of right lower lip of Dog No. 10. ×120. The periacicular zone of fibrous tissue has necrosed. Portion of it remains with well-developed vessels but an ill-defined edge merging into the necrotic tissue.

FIG. 12. Section of right upper lip of Dog No. 10. ×10. The central necrosis of the periacicular zone with ulceration on to the surface is illustrated.

spread rapidly until the whole of the whitened area of skin was removed except a strip at the dorsal edge. At the ventral edge the process extended until the whole of the scar was removed when a clean red granulation tissue commenced to replace the yellow necrotic material. At this stage the dog was killed and all the microscopic features which were found[4] in the human material of radionecrosis were present (Fig. 13). The scar on the left lower lip resembled those on the other areas of the left side.

12	8 months	Areas on the legs and lower faces show the usual increased elastic tissue, fibrous tissue and changes in the epidermis. Those on the right side have ill-defined very small areas of more hyaline tissue at the center than on the left side but it is not nearly so marked as previously. That on the left upper face is similar to the other areas. At 5½ months an area of ulceration appeared in the center of the scar on the right upper lip. This extended until at 6½ months the whole of the scar except the edges were involved. A biopsy specimen was taken and showed the features seen in Dog No. 11. As in Dog. No. 11 no marked endarteritis was seen. The dog was allowed to live so that the course of the ulcer might be observed. At seven months the whole of the white scar area was involved with islands of red granulation tissue appearing in the yellow necrotic base. The bone was not involved. In another week almost the whole of the yellow material had disappeared (aided by the dog's efforts at toilet) and 14 days later the whole ulcer was epithelialized over a marked tissue defect. Section a week later showed a "normal" regeneration of epithelium over a vascular granulation tissue in contrast with the comparatively avascular tissue which is present when healing takes place after the initial "reaction" to radium.
13 and 14	9 and 10 months	The only difference between the scars on the two sides was greater suppleness on the left side, microscopically, the fibro-elastic tissue denser with thicker bundles of fibers on the right side.

It was not considered at all likely that the gold and nickel containers by any intrinsic activity would result in altered tissue reactions. For this reason controls us-

FIG. 13. Dog No. 11 irradiated seven months previously. Necrosis of the irradiated area with exfoliation of almost the whole scar is seen.

ing blank containers were not carried out.

To study the possibility that the scar tissue resulting from lightly filtered radium might constrict the vessels leading to ischemia, histamine was pricked into the center of hard fibrotic scars on the lips of patients treated three years previously with radium needles of 0.5 mm. platinum filtration. At the points of puncture a red zone of capillary dilatation surrounded by an area of edema 4 mm. in diameter occurred. Flare was not discerned but the patient complained of irritation. Since the pressure in the dilated capillaries is probably less than that in the ordinary capillaries it is evident that the fibrous tissue does not constrict them.

The vulnerability of irradiated tissue was investigated by implanting a capillary tube of gold 0.3 mm. wall and 2 mc. per cm. length circularly in the subcutaneous tissues of the right foreleg of three guinea pigs. The ends were twisted together. Guinea pigs quickly remove a straight needle by gnawing through the tissues and anchoring thread. These were left in position for five days and then removed. The reaction was at its height in three weeks and healed in six weeks. Fifty per cent nitric acid was then applied in a small piece of cotton wool under a thick layer of adhesive strapping to this area and a corresponding area on the left foreleg. This dressing was kept damp with acid for three days by injecting more acid under the strapping. This resulted in an ulceration of the right leg which persisted four weeks and led to a loss of practically the whole of the tissue altered by irradiation. On the left leg a superficial ulceration occurred which granulated and healed rapidly in from seven to fourteen days.

DISCUSSION

The one outstanding feature of these results is the occurrence around the more lightly filtered source of radiation of an area of fibrous tissue which is fairly limited from the changes in the fibrous tissue which constitute the more widespread reaction to the γ rays. It is hyaline in type and appears to be the part of the scar in which the late necrosis takes its origin. It is evidently a tissue with a metabolism and degree of differentiation changed from that of the surrounding fibrous tissues; it would not further elucidate the problem to suggest that the greater amount of collagen substance indicates a degeneration of the cells; it is an index of altered metabolism. That this manifestation alone might indicate an increased biological age of the cells and indicate an earlier death of these tissues than of the surrounding tissue is unwarrantable. From the analogy of other collagenous tissues, however, it is evident that an increase of the intercellular substance is usually accompanied by lowered metabolism per gram of tissue and by a decreased vasculature. The hypothesis that this reduction of vasculature is due to strangulation of the vessels by contraction of the fibrous tissue is untenable. The paradoxical flushing which occurs in scars indicates that dilatation of the vessels in a scar may take place; this would not be possible if the vessels were actually constricted by a tough collagenous tissue. On pricking histamine solution into scars following radium implantation it was found that dilatation of capillaries with edema occurred. It thus becomes evident that the diminished vasculature of the irradiated tissue more probably has as its basis some reaction of the vessels to the diminished metabolism of the tissues rather than a simple constriction of the vessels by the more heavily formed collagen. No evidence of marked endarteritis obliterans was found; the observations of skin temperature in humans suggest that no marked general blockage of major vessels occurs. Thus the relative absence of capillaries from the hyaline areas on the right side cannot be considered to be the actual cause of the death of this tissue nor is there evidence that such a result may arise from endarteritis obliterans of the larger arteries.

Irradiated tissues are more vulnerable to infection and physical and chemical agents

than are normal tissues. This was apparent in Dog No. 12, and in clinical cases where as soon as the whole of the scar area was exfoliated normal healing occurred. Presumably infection is the cause of the death of tissue in these cases but frequently ultraviolet light will precipitate death of the tissues. In lesions produced on guinea pigs by radon needles similar to those used on dogs, 50 per cent nitric acid precipitated sequestration of the scar but on the normal skin produced a shallow granulating ulcer only.

The occurrence of necrosis in the periacicular area of fibrosis with no communication to the surface in the lower face region of Dog No. 10 indicates that necrosis does not in all cases arise from the vulnerability of the tissue to external agents. The distribution and relation of tissues in the area on the upper face also indicates a deep necrosis preceding the superficial ulceration. Clinically it is often apparent that a widespread deep necrosis is present before the whole area breaks down. No satisfactory explanation of these phenomena appears unless it be that in the living body a phenomenon similar to that observed by Spiers[4] in vitro takes place and the longevity of the tissue is reduced by a reduction in the number of reproductions possible for the cell. The greater granulation tissue reaction around the more lightly screened container would "use up" a greater number of the "lives" of the irradiated cells than would the hyalinization around the more heavily filtered container.

When necrosis has taken place in the periacicular zone, infection may be considered to be the usual cause of spread of the necrosis to the other irradiated tissues which behave like most other avascular tissues with a high intercellular content in that a massive continuous death of tissue occurs. It is impossible to define what this type of reaction has to do with altered metabolism of the tissue. It ceases at the ill-defined edge of the irradiated tissue.

SUMMARY

(1) In the tissues of fourteen dogs irradiated in corresponding areas by similar doses of primary γ radiation but in which the filtration was 0.55 mm. equivalent of platinum (0.375 mm. Au with nickel outer covering) and 0.8 mm. equivalent in gold a peculiar periacicular formation of hyaline tissue took place over several months in the former case.

(2) Four examples of later radionecrosis had their origin in this tissue.

(3) No evidence could be found that this death of tissue resulted from any specific action of the radiation on the vasculature. It is suggested tentatively that the essential difference in irradiated tissues from normal tissues is one of reduced number of reproduction cycles, so that in the case of the more lightly filtered radiation with a greater reproduction activity in the granulation tissue around the needle this number of cycles is more rapidly "used up" than in the case of the more highly screened radiation, where the periacicular granulation reaction is less marked and the main change is hyalinization, not a change to less mature tissue.

(4) It is indicated that the relative avascularity of irradiated tissue is the reaction of the vessels to the altered activity of the fibrous tissue rather than the result of any constricting effect by increased intercellular substance of this tissue.

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INTENSITY MEASUREMENTS OF RADON IMPLANTS IN VIVO AS AN INDICATION OF ABNORMAL BIOLOGICAL REACTION

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RADON has occasionally failed to produce the acute tissue reaction and growth regression that is customarily observed from interstitial irradiation. Our first thought was leakage of radon from the seeds, but this has not been supported by experience. Upon the hypothesis that one or more seeds may be lost from the tumor tissue, we present a method for the detection of abnormal loss of emanation during the period of active radiation from radon seeds.

INSTRUMENT

The instrument used in this series of measurements was a "fountain-pen type" electroscope, developed by Dr. Charles C. Lauritsen, primarily as an instrument for indicating the amount of scattered radiation around roentgen therapy installations. The sensitivity of this instrument was suitable for the intensities encountered in our present problem.

The same principle is adopted for this electroscope as in the former "gold-leaf" type, but the movable member is a metal-coated, very fine quartz fiber. A cross-arm, also of very fine quartz, is cemented laterally on the end of the active fiber and appears through the microscope as a vertical line moving across the scale as the radiation ionizes the air in the electroscope body and allows the charge on the fiber to leak off. Essentially the instrument consists of a microscope tube, with objective lens and ocular, and the minute fiber system with the cross-arm in the focal plane of the optical system. The size and shape are the same as an average fountain pen.

To prepare for a measurement of radiation intensity the electroscope is "charged up" by means of a vacuum tube rectifier. The potential required is approximately 100 volts and this is applied to the quartz fiber by a simple switch arrangement, and the fiber is repelled from its neutral position due to electrostatic forces. The microscope scale is so arranged that the indicating cross-arm is at the zero position on the scale in the fully charged condition. Loss of charge, due to presence of radiation, is then observed by the indicator moving along the scale.

MEASUREMENTS

After charging and determining the scale reading before exposure, the surface upon which the instrument is to be placed is carefully studied for landmarks. The electroscope should be held as far away from the radiant energy as possible to avoid an effect before the start of the timed interval. Then the electroscope is placed in position and at the same time the stop-watch is started and the exposure continued for a definite interval. A series of three or more determinations is made to arrive at a good average value for each measurement.

The exposure time is varied according to the initial intensity of the radiation, days of expended energy, distance and thickness of tissue between the seeds and the surface position of the electroscope. The time is so adjusted, by trial readings, that the electroscope deflection is always over the same portion of the scale (from 20 to 35, or a deflection of approximately 15 divisions). This prevents a possible non-linearity of response along the scale from affecting the interpretation of deflection per second as an accurate indication of relative intensity.

In order to tabulate the data in terms of

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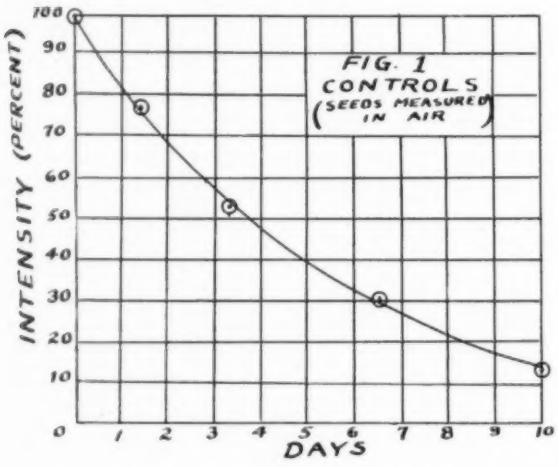
a uniform quantity as an indication of arbitrary intensity values, the readings are reduced to the quantity "divisions per second," usually of the order of 1/10 division per second. The electroscope is not calibrated in terms of roentgens or millicuries, since only values of relative intensity are necessary.

The rate of decline of the activity of radon is well known and its "half-life period" (time during which the intensity



drops to 50 per cent of its original value) has been definitely determined as 3.8 days. The formula for the decline of intensity is $I = I_0 e^{-at}$, where I is the intensity at any time "t" after the original determination of the intensity I_0, and "a" is the coefficient of decline which may be determined for use with time "t" in days or hours, as desired. The value of "a" for time "t" in days is 0.1812. For time in hours, "a" has a value of 0.00755. This expression is a logarithmic function and the curve is of the form shown in the charts as a solid line. Figure 1 shows the theoretical curve of decline and experimental observations on the control seeds.

A major change in the intensity of the radiation is immediately obvious, as in Case 382, G. M. B., where a large number of the implanted seeds were lost during severe diarrhea. By immediately reducing the data for each measurement and keeping a "running chart" of intensity, minor variations may either be accounted for by known changes in dressing thickness, etc., or a decrease of the order of magnitude of a single seed may be easily recognized. The variations from the theoretical curve are usually less than the percentage variation due to loss of a single seed. The electroscope was placed as nearly in the identical position as was possible each time, but variations in dressing thickness, posture, and tissue contours due to position, made exact duplication impossible.

The period of observation extended over ten days, with readings being made at intervals such that approximately the same percentage of loss took place between each successive pair of observations.

CASE HISTORIES

The following cases were selected to demonstrate the measurements of radon seeds in various locations in the body. The majority of the growths in this series were of the low grade, radiation resistant type and the fractional or divided dose roentgen therapy failed to cause complete regression. It was necessary to supplement with interstitial irradiation and the cases illustrate the necessity of careful observation for the adequate and desired radiation reaction.

Case 410. C. P., male, aged sixty-eight. Chief complaint ulcer in the left floor of the mouth for one year. On examination, there was a crater-like ulcerated mass occupying the left floor of the mouth from the frenum posteriorly for a distance of 4.0 cm. There was no invasion of the tongue, and no extension onto the alveolar ridge. The sublingual gland was infiltrated for a depth of approximately 0.5 cm. No glands were found in the neck.

Pathological diagnosis: Squamous cell carcinoma, Grade II.

On May 1, 1935, after preliminary high voltage roentgen therapy, nine radon seeds of approximately 1.4 mc. each were implanted uniformly in the growth. The total amount of interstitial radiation was 12.6 mc. or an integrated dosage of 1,680 mc-hr.

The combined external and interstitial irradiation caused an acute reaction on the skin of the cheek and neck and the mucous membrane surfaces on the left side of the mouth. The reaction appeared on the fifth day after the im-

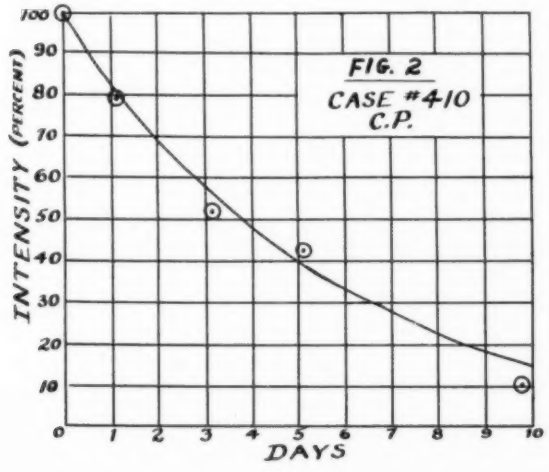
plantation of seeds and lasted for seven weeks. This effect was entirely satisfactory and corresponded with the radiation applied. At present there is no evidence of disease nor deformity of tissues at the site of the primary growth.

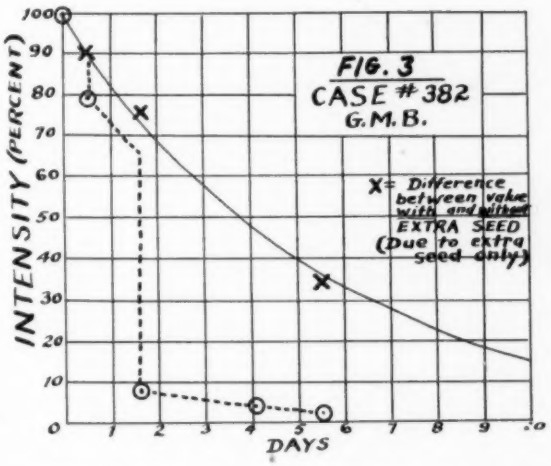
Measurements were taken with the electroscope placed parallel to the alveolar ridge from the symphysis, posteriorly. This position was adhered to as nearly as possible for all subsequent measurements. Figure 2 shows the chart for this case. The maximum variation from the theoretical curve was 8 per cent except on the tenth day when the intensity was too low for accurate determination. The loss of a single seed would account for a deviation of 11 per cent. Accurate measurements were possible because of definite anatomical landmarks and an absence of dressings.

Case 382. G. M. B., female, aged forty-two. Chief complaint, rectal bleeding and mucus for two months. On proctoscopic examination a dome-like, ulcerated growth at the rectosigmoid juncture was demonstrated, measuring 3.0×2.0×? cm. The mass was partially fixed to surrounding tissues, but not to the pelvic bones.

Pathological diagnosis: Adenocarcinoma, Grade III.

After preliminary high voltage roentgen therapy twelve seeds of approximately 1.1 mc. each were implanted into the growth on April 5, 1935. The initial intensity of interstitial irradiation amounted to 12.5 mc. or an integrated dosage of 1,660 mc-hr. The growth receded somewhat in diameter as a result of the preliminary high voltage roentgen therapy, but, more important, the thickness of the mass was





greatly reduced and it was difficult to implant the seeds so that they would remain in place.

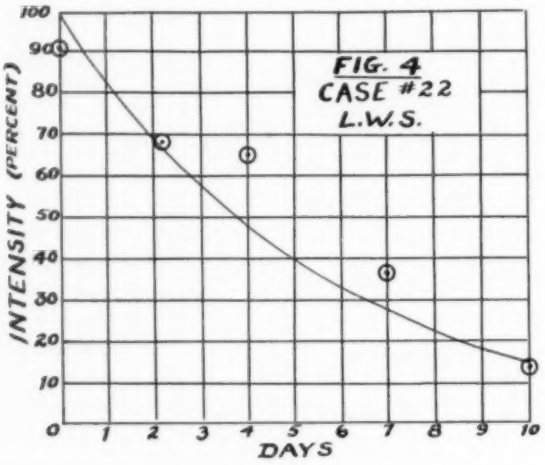
Measurements were taken with the electroscope against the symphysis pubis. One radon seed of a similar strength to those used was kept as a control and the intensities were taken with and without the presence of the extra seed. For the control measurements the extra seed was placed over the fifth lumbar vertebra. The chart is shown in Figure 3. The first measurement was made April 5, 1935, at 8:00 P.M. This was twelve hours after the implantation. The next morning at 10:00 A.M. it was quite evident that approximately 10 per cent of the radon, or one seed, had become dislodged. During the night of April 6, the patient had a severe diarrhea, and had frequent passages of mucus and some blood. On April 7, at 10:00 A.M., practically all of the radon had passed out of the bowel and only one seed remained in place for the remainder of the measurements.

The biological effects from the interstitial irradiation were entirely inadequate. The radiation membrane did not appear and the growth regressed only slightly. However, it was possible to pass the proctoscope by the growth which had been impossible before this irradiation.

Comment. In certain viscous organs of the body, it is extremely important to know whether radon remains in place for its period of practical activity. It is extremely difficult to implant seeds in a thin wall, such as the sigmoid, and depend on their permanence. In this case, the seeds were implanted at an oblique angle, and a particular effort was made to place them in

the muscle and as deeply as possible with safety.

The importance of this observation on a patient cannot be overestimated. In the above case not only was it possible to repeat the dose immediately without loss of time, but it avoided a mistaken critical judgment of the radiation effect on this particular tumor.



Case 22. L. W. S., male, aged sixty-five. Chief complaint, a tightness and pain in the right side of the throat for three months. On examination, there was a nodular growth on the right pharyngeal wall, from the inferior tonsillar border to a point opposite the epiglottis. The growth infiltrated the lateral pharyngeal wall deeply, and there was invasion into the base of the tongue below the lingual tonsil. No glands were found in the neck.

Pathological diagnosis: Squamous cell carcinoma, Grade II.

After preliminary high voltage roentgen therapy, thirteen seeds of approximately 1.4 mc. each were implanted uniformly throughout the growth. A total amount of 18.2 mc. was used, or an integrated dosage of 2,420 mc-hr.

The normal reaction appeared on the pharyngeal mucosa and skin from the high voltage roentgen therapy, but the growth did not regress completely. During the height of this reaction the seeds were implanted and evident regression was noted on the eighth day. The reaction persisted with a whitish membrane for six weeks. The area healed promptly and there is no evidence of disease.

Measurements were taken with the electroscope placed at the right angle of the jaw. The first measurement was made immediately after the implantation of the radon on May 10, 1935, at 11:00 A.M. Subsequent measurements were taken over the following ten days. The marked deviation of some of the observations from the theoretical value was due to the position of the electroscope. The landmarks were not accurately established and the slight misplacement resulted in this wide variation. This difficulty was largely avoided in later cases by determining better landmarks before starting the series.

Comment. Radon seeds must be implanted with attention not only to accuracy of location but with some thought of permanence. Seeds implanted into ulcerated areas must be inserted deeply enough to be imbedded in firm tumor tissue. The trocars carrying the seeds may be injected at one angle and withdrawn at a different angle. In this way the track made by the trocar can be obliterated and the seeds prevented from coming out through the track of injection.

Case 421. J. M. J., male, aged sixty-one. Chief complaint, hoarseness for five months. On indirect examination of the larynx, there was a cauliflower growth 1.0 cm. in diameter, located at the juncture of the middle and the anterior third of the left cord. The base was broad and it infiltrated the cord considerably, although movement was not impaired. The anterior commissure was not involved. No glands were found in the neck.

Pathological diagnosis: Squamous cell carcinoma, Grade II.

After preliminary high voltage roentgen therapy, three radon seeds of approximately 1.5 mc. each, or a total of 4.5 mc., were implanted. This resulted in a total dosage of 600 mc-hr.

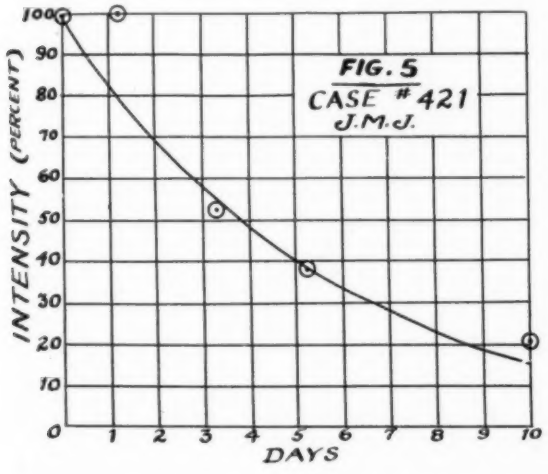
The reaction from the roentgen therapy caused an epidermitis and epithelitis, but the growth did not regress completely. The radon seeds caused a complete disappearance of the growth on the twelfth day. The membrane reaction persisted seven weeks and now there is no evidence of disease.

Measurements were taken with the electroscope placed over the left cricothyroid membrane. The first measurement was taken immediately after the implantation of the seeds

on May 1, 1935, at 11:00 A.M. The subsequent measurements were made over the following ten days. Figure 5 shows this series of observations. Only three seeds were used and the deviation was in each determination much less than the 33 per cent due to one seed.

Comment. Many times it is desirable to implant radon seeds through small instruments where visualization is difficult, and often it is impossible to gain sufficient exposure for a three-dimension image. The seeds in this case were implanted through a laryngoscope, and inspection was relatively easy, but the thickness of the growth and the cord could only be estimated. It is entirely possible that many times radon seeds are inserted through the cord and finally lodge in one of the bronchi.

Previously radon seeds were implanted by one of us in several other esophageal growths where exposure was much more difficult. A method of detecting their continued activity in the growth would certainly have added to the accuracy of the dosage, and confidence in the result.

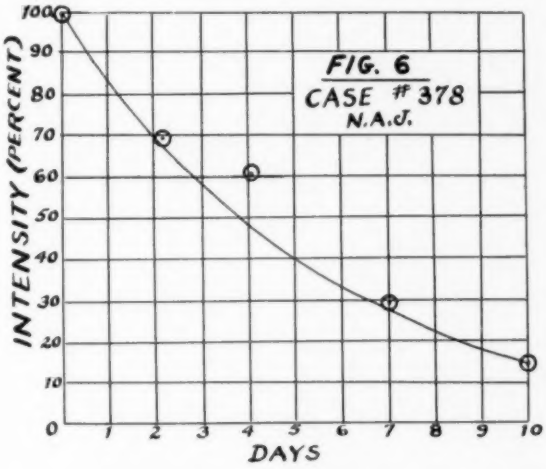


Case 378. N. A. J., female, aged thirty-nine. Chief complaint, soreness of the tongue and left side of the throat, with blood-streaked sputum, for the past six weeks. On examination, there was an ulcerated area on the left anterior tonsillar pillar, which infiltrated the base of the tongue in the region of the lingual tonsil. The area was deeply indurated, and the involved tissue measured approximately 3.0 cm. in diameter. No glands were found in the neck.

Pathological report: Squamous cell carcinoma, Grade II.

After preliminary high voltage roentgen therapy, eleven radon seeds of approximately 1.2 mc. each were implanted uniformly into the involved area. A total amount of 14.1 mc. was inserted, or an integrated dosage of 1,875 mc-hr.

Measurements were taken with the electroscope placed against the left angle of the jaw.

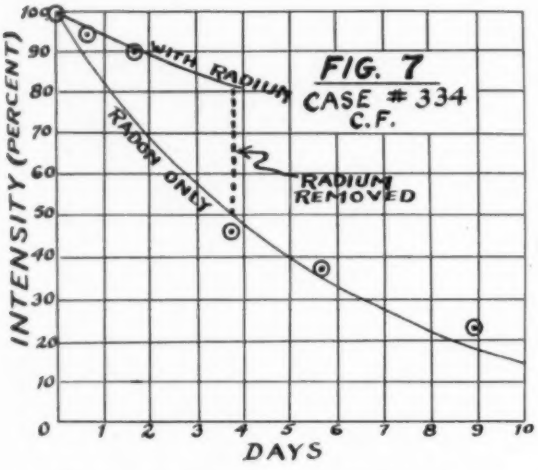


The first measurements were made immediately after the implantation on May 10, 1935, at 10:00 A.M. Subsequent measurements were taken over the following ten days. The curve for this series is shown in Figure 6.

Comment. Measurements by electroscopes of high degree of sensitivity are very inaccurate unless great care is taken to define the exact landmark for each series of measurements. The variations in the measurements on this patient were due primarily to inability to accurately place the electroscope in the same location each time. We feel that the slight variation from the theoretical curve may be due to the fact that some of the measurements were taken with the patient prone, and at other times in a sitting position. Swelling of the tissues after the implantation and the attempt to take the measurements through dressings of varying thickness must also be considered.

Case 334. C. F., female, aged fifty-five. Chief complaint, lump observed in the region of the right angle of the jaw four years previously.

During this interval, three operations were performed for local recurrences. On examination, there was an irregular, indurated mass, 5.0 cm. in diameter, which covered the right angle of the jaw, and collared the lower part of the ascending ramus, and presented in the posterior portion of the floor of the mouth. The mass was firmly adherent to the mandible, and all surrounding structures.



Pathological report: Squamous cell carcinoma, arising from squamous cell elements in the mixed tumor of the parotid.

After preliminary high voltage roentgen therapy, an upper right radical neck dissection was performed. The growth had invaded the jugular vein, and the involved vessel was resected with the mass. It was impossible to remove the part of the growth adherent to the carotid vessels. Nine radon seeds of approximately 1.6 mc. each were implanted in the suspicious areas. Two radium capsules containing 25 mg. in 0.5 mm. platinum shields were inserted in the wound after the operation through a Penrose drain.

Measurements were taken with the electroscope placed at the right angle of the jaw, over the dressing. The observations are graphically shown in Figure 7. The first measurement was made on April 5, 1935, at 8:00 P.M.

Subsequent measurements were taken daily until the fourth day, and the measurements closely approximated the theoretical curve for the combination of radium and radon which was used. On the fourth postoperative day, the radium was removed and the measurements continued to closely simulate the theoretical curve for radon only.

Comment. This case represents a circumstance commonly encountered in the operating room where the involvement was more extensive than the preoperative examination indicated. An inadequate dosage of radon seeds was available and it was necessary to substitute radium. This was accomplished by suturing a Penrose drain in the depth of the wound. Later sterile radium capsules were inserted into the rubber tubing in tandem and left for a four day period.

The biological effect from the above combined therapy was acute and caused an epithelitis and a severe epidermitis which persisted for nine weeks.

CONCLUSIONS

1. Abnormal biological reaction from radon may be due to an immediate or early loss of seeds from the growth.

2. A method is presented for the detection of abnormal loss of emanation from tumor tissue during the period of active radiation from the radon seeds.

3. Radon seeds must be implanted with attention not only to accuracy of location, but with some thought of permanence.

4. Case histories are presented to demonstrate the value of knowing definitely that the interstitial dosage was delivered according to the original plan of treatment.

NOTE. The high voltage roentgen therapy for the above cases was given daily by the divided dose method. The treatment period ranged from eighteen to thirty days and 250 to 350 r was delivered at each treatment. The total dosage was from 5,000 to 7,000 r. The machine was operated at 200,000 volts, 15 milliamperes, 10.0 cm. cone, 50.0 cm. distance and a Thoraeus filter equivalent to 2.0 mm. of copper.

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NON-NEOPLASTIC TUMEFACTIVE LESIONS OF THE LARGE INTESTINE

INFLAMMATORY TUMEFACTIONS*

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IN THE large intestine, carcinoma is encountered far more frequently than all other malignant and benign tumefactive processes combined. However, non-neoplastic, that is, inflammatory, tumefactions occur often enough to demand serious consideration in the differential diagnosis each time the idea of "tumor" or "growth" is suggested.

Although of varied etiology and pathogenesis, the inflammatory tumors of the colon bear clinical and morphologic resemblances to each other and to true neoplasms so striking that it is always difficult, and without microscopic examination often impossible, to distinguish between the various etiologic types of inflammatory tumors, and between these and true neoplasms. Because the diagnostic elements elicited at roentgenologic examination reflect the gross morphologic characteristics of normal and diseased parts—their ultimate validity depending entirely on the fidelity with which this is done—the assumption that the roentgenologic diagnosis of the lesions under special consideration here should also be attended with considerable difficulty is not altogether an illogical one. Fortunately, however, true neoplasms of the colon manifest themselves roentgenologically by signs so consistently distinctive as to be practically pathognomonic. When these characteristic roentgenologic manifestations of neoplasm are not elicitable, the roentgenologic diagnosis of non-neoplastic tumor is made simply by exclusion, since no alternative diagnosis is possible. That inflammatory tumefactions are entirely lacking in distinctive roentgenologic signs is, however, not to be inferred. Their roentgenologic manifestations are, in fact, only somewhat less distinctive than those of true neoplasms, but the diagnostic syndrome is negative in character rather than positive. By this I mean to say that the diagnosis of inflammatory tumor is made more by noting that the roentgenologic signs distinctive for neoplasm fail to be exhibited than it is by setting up a syndrome of roentgenologic signs characteristic of the non-neoplastic tumor.

The diagnostic problem thus resolves itself into two parts: first, the mere demonstration of the existence of a tumefactive lesion, and second, the determination of its neoplastic or non-neoplastic nature. It is to be assumed that the roentgenologic examination can be made to establish the presence of any tumefactive lesion of the colon at least as early in the development of that lesion as it is able to cause symptoms and to be manifested by clinical signs.

All tumefactive processes manifest themselves roentgenologically by what is called a filling defect. This may be defined as a subtraction from the normal outline of the luminal contours. It is produced chiefly by protrusion of the tumefactive substance toward and into the lumen, partly by diminished distensibility of the infiltrated wall. Local spasm also contributes to the deformity. The roentgenologic picture is, in fact, the shadow of a barium cast, the matrix of which is the intestinal lumen. Thus the filling defect corresponds morphologically to the intraluminal contours of the lesion which is its cause. The extraluminal features of a given tumefactive process are available only by inference from roentgenologically controlled

* Read at the Thirty-sixth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 24-27, 1935.

manipulation of the organ under investigation. It is hardly necessary to emphasize that to have significance, the actuality and permanence of a filling defect must be determined with finality. This means that it must be viewed from various angles, and under the influence of active and passive movement. It must show no change in location or essential appearance after manipulation, or after the administration of antispasmodic drugs, or on reëxamination.

The presence of a genuine filling defect, then, encompassing a relatively short segment of the colon, signifies tumefaction. The next step is the determination of its nature. Is it neoplastic or inflammatory?

To answer this question with confidence and with consistent accuracy, the importance of a thorough familiarity with all of the roentgenologic signs of neoplastic disease of the colon cannot be exaggerated. The roentgenologic manifestations of inflammatory tumefactions will therefore be discussed by drawing comparisons and contrasts with those of true neoplasms, of which carcinoma is by far the most frequently encountered representative. Although all carcinomas of the colon do not have identical roentgenologic appearances, yet some roentgenologic characteristics are common to all of them. Carcinoma is primarily a disease of the colonic mucosa. It is practically always confined to a relatively short segment of the bowel, and produces a marked but relatively pervious narrowing of the lumen. It causes clinical obstruction only when complicated by perforation, or by partial or complete intussusception. The "canalization" usually has smooth tubular contours. Its course may be straight or irregularly angular, but almost always it is somewhat eccentric to the normal intestinal lumen proximal and distal to it. A most significant feature is the abrupt demarcation between involved and uninvolved intestine. A mucosal relief pathognomonic of neoplasm can be described (Fig. 1), and this is the most fundamental, the most reliable, and the most generally applicable, although not the

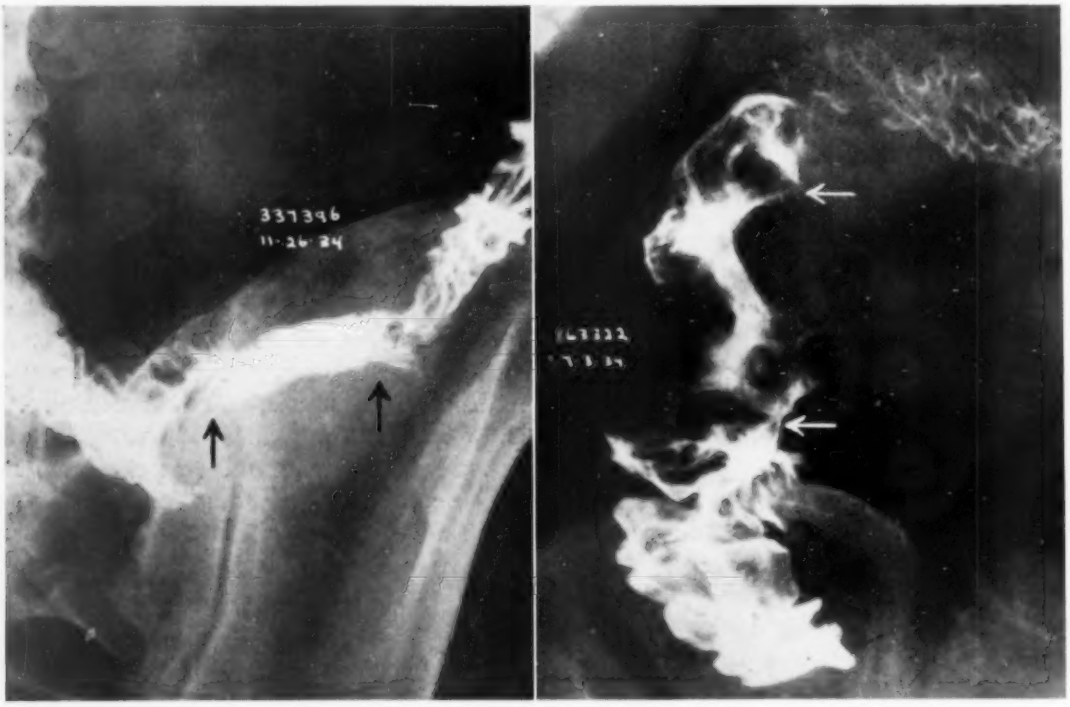

Fig. 1. Between the arrows is the characteristic relief pattern of carcinoma; sigmoid colon (left), ascending colon (right). The roentgenologic diagnosis was verified at operation.

most easily elicited, of all the roentgenologic signs of neoplasm of the colon.[4]

Different histologic and gross morphologic types of carcinoma present different intraluminal relief patterns, but the normal relief is always entirely obliterated. Often, especially with the annular or fibroscirrhous carcinomas, the internal aspect of the involved segment is flat and roughly granular, and there is a peculiar stiff rigid look about it. Other types of carcinoma exhibit this granular surface also, but as-

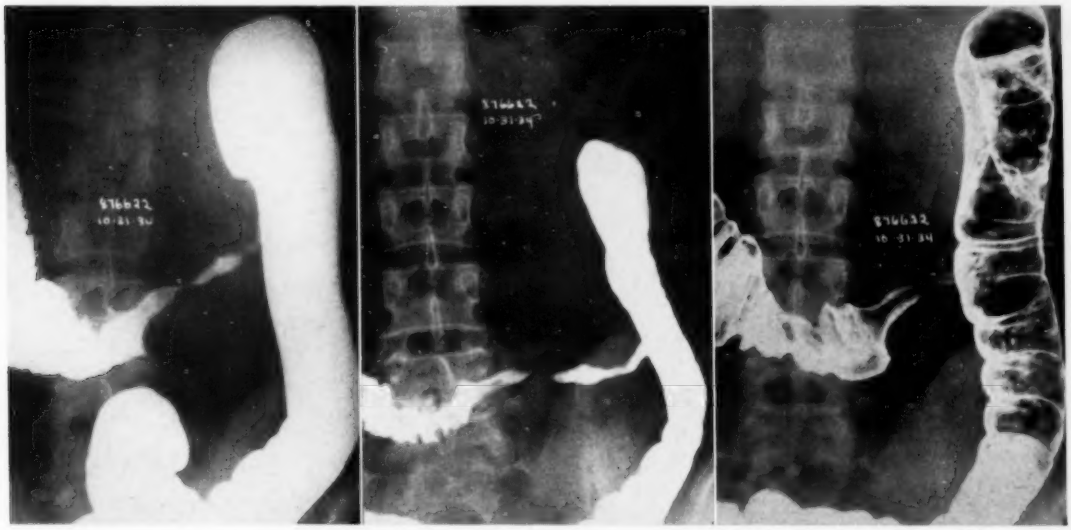

FIG. 2. Carcinoma of distal transverse colon. The distal half of the transverse colon, the splenic flexure, and the proximal descending colon after distention with the opaque enema (left), after evacuation of enema (center), and after insufflation (right). Roentgenologic diagnosis was verified at operation. The involvement extends over an unusually long portion of the bowel, but the relief pattern of the channel, the abrupt demarcation between involved and uninvolved intestine, and the crescentic proximal and distal termini of the filling defect are pathognomonic.

sociated with it is a disordered arrangement of irregular depressions and elevations, resulting in a gnarled, coarsely jagged relief. Polypoid carcinoma produces a marginal filling defect only when ulcerated, in which case the relief pattern reflects its saucer-like form; but again the granular amorphous character of the surface is apparent, broken irregularly by elevations corresponding to the excrescences of carcinomatous substance on the surface. Invariably apparent, however, and the most telltale feature of the neoplastic relief pattern, is the abruptness with which it is delimited from the uninvolved mucosa proximally and distally contiguous to it. An expression of this sharp delimitation is the seemingly persistent tendency of the unperforated neoplastic lesion toward intussusception. This is manifested roentgenologically by the appearance of unilateral or bilateral crescentic spurs at the proximal or distal extremity of the channel, or both, at the time when the lesion and the adjacent intestine are well distended with contrast material (Fig. 2). This crescentic shadow complex is interpreted as an effort of the lesion to insert itself into the lumen of the bowel, or as an attempt of the contiguous intestinal wall to fold itself around the tumor. Whatever the interpretation of this phenomenon is, only neoplastic lesions exhibit it, and it is a pathognomonic roentgenologic sign, particularly valuable when the channel is apparently or really impervious to injected or orally administered contrast material.

The roentgenologic diagnosis of neoplastic versus non-neoplastic tumefaction would be very much less complex and difficult were it not for the frequency with which neoplasms of the colon are compli-

cated by perforation. Almost always subacute or chronic rather than acute, the inflammatory pericolic process attending perforation extends in both directions from the site of the original lesion, and so overwhelms the neoplastic process as to make the lesion take on the general appearance, and even the clinical signs and symptoms, of an inflammatory tumor. Roentgenologically, a filling defect is produced which resembles that of the inflammatory tumors very closely. As a result of the pericolic inflammatory process which is set up, the filling defect occupies a much longer segment of bowel than does the original lesion. The sharp demarcation between involved and uninvolved intestine disappears, and the filling defect tapers off gradually into normal external contours. Proximal and distal to the site of the original lesion the mucosal pattern is markedly disturbed but not destroyed, and it is similar in almost all respects to that seen in association with inflammatory tumefactions. The tendency toward intussusception disappears. Diacritical roentgenologic signs of the original lesion are not, however, obliterated beyond the point where roentgenologic methods fail to redeem them, and it is here that familiarity with the internal relief of the neoplastic lesion is of particular value. Situated often at or near the precise midpoint of the filling defect is an area manifesting a relief entirely different from that immediately proximal and distal to it: the pathognomonic internal relief of neoplasm, a description of which was just attempted (Fig. 3).

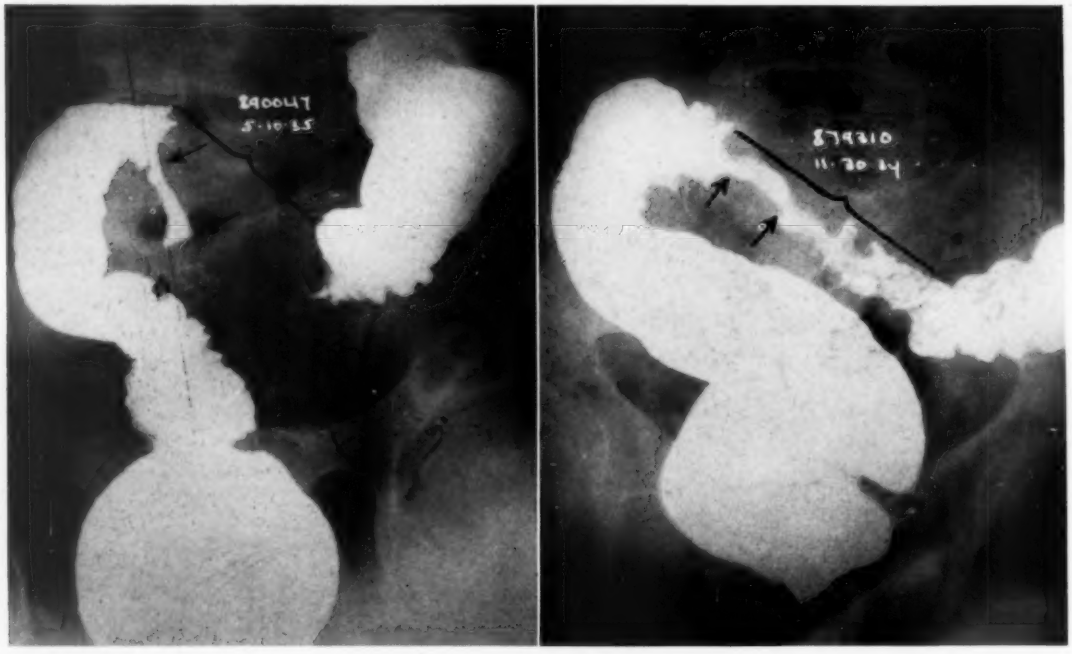

Fig. 3. Perforating carcinoma of the sigmoid colon. Between brackets is the elongated poorly demarcated filling defect; between arrows, the characteristic neoplastic relief pattern of carcinoma.

The fundamental importance of obtaining adequate visualization of the entire extent of the filling defect, and of making a most careful study of the structural detail of its internal relief, should, in view of what has been said, be obvious. To do this, antispasmodic drugs, administered to full physiologic effect, are often useful in diminishing the increased irritability associated with these lesions. Often too, roentgenologic examination after a short therapeutic regimen directed at alleviating the inflammatory component of the filling defect will permit the establishment of a diagnosis, otherwise of necessity left indeterminate. It may be said safely that a dependable roentgenologic diagnosis of

"neoplasm with perforation" can be made whenever it occurs, and to confuse the condition consistently with the non-neoplastic tumefactions is to fail to exact the full diagnostic yield of the roentgenologic examination.

The filling defect produced by inflammatory tumefactions is best defined as one in which evidence of true neoplasm cannot be demonstrated. It is essentially a constriction of the lumen, embracing only a part of one of the divisions of the large intestine, but it usually is a longer defect than the one associated with neoplasm. The amount of constriction also varies within considerable limits. Some inflammatory tumors have narrowed the lumen to such an extent as to render it entirely impervious, while others, of the same etiology, have produced a narrowing which is hardly perceptible. Inflammatory disease in general is progressive and to a certain extent self-limited, and the gross morphologic as well as roentgenologic appearances depend largely on the stage of development at which the lesion is observed. The cecum and adjacent ascending colon, and the sigmoid, hepatic, and splenic flexures, seem to be sites of preference but inflammatory tumefactions may be found in any portion of the bowel.

As has been indicated, neither the length of the filling defect nor the amount of constriction is constant, but all inflammatory tumors are alike in this respect that the filling defects they produce all fade off gradually, almost imperceptibly, into the normal contours of the intestine proximal and distal to the constricted area (Fig. 4). Destruction of the mucosa may or may not take place, and when it is observed it is practically always in association with those inflammatory tumors caused by an etiologic agent which under other circumstances causes ulcerative colitis. The tuberculous, amebic,and the streptococcic granulomas are the principal examples of this group of inflammatory tume-

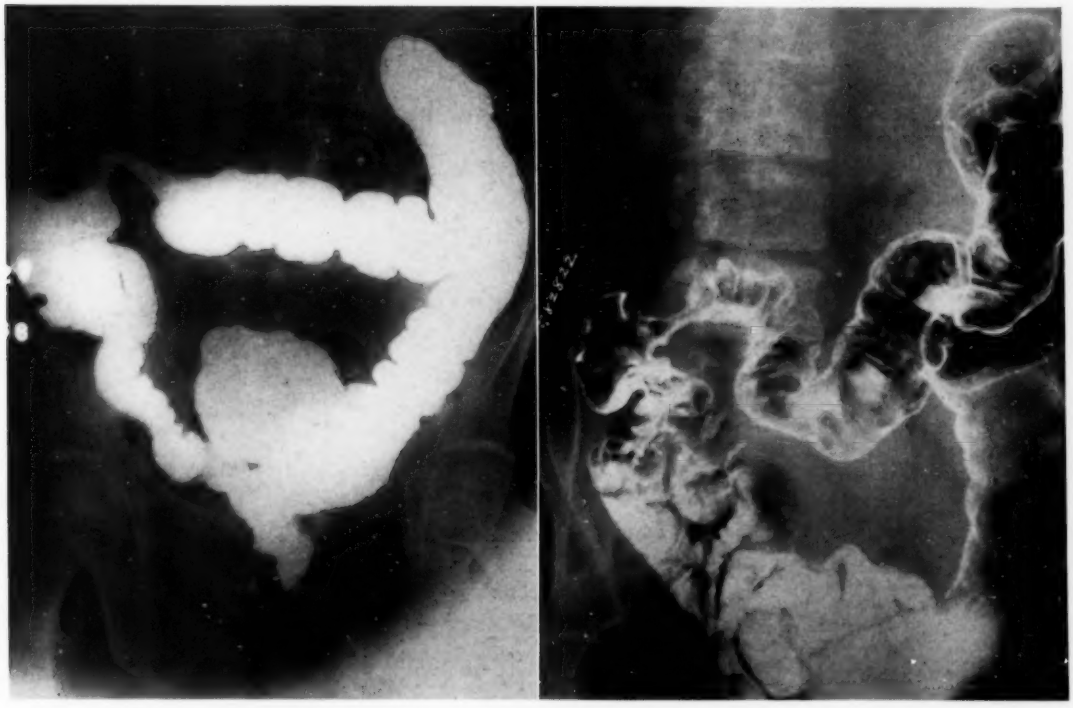

Fig. 4. Tuberculoma involving the hepatic flexure (opaque enema, left) and carcinoma involving the hepatic flexure (double contrast method, right) placed side by side to contrast the roentgenologic appearances of the non-neoplastic and the neoplastic tumefactions.

factions. The most important pathologic changes are found in the submucosal structures, and while the mucosa has always undergone some pathologic change, it may be unbroken throughout the entire extent of the lesion. Rarely, multiple inflammatory lesions are encountered in the same colon. Combined involvement of ileum and cecum is commonly seen when an inflammatory tumor involves this region, a phenomenon never seen with neoplasm unless perforation has taken place. All of these morphologic features are reflected faithfully in the roentgenologic picture, but after all is said and done the diagnosis of inflammatory tumor is made by eliminating the possibility of neoplasm as the underlying lesion.

When the roentgenologic examination has demonstrated that a tumefactive lesion is present, and has offered its dependable conclusions about the neoplastic or non-neoplastic nature of the tumor, it has made about as great a contribution to the final diagnosis as may be expected of it. There are no fundamentally reliable roentgenologic signs by which the various etiologic types of inflammatory tumor can be distinguished from each other, and the final roentgenologic diagnosis often, if not usually, reads "non-neoplastic tumefaction of indeterminate etiology" (Fig. 5). This noncommittal phrase is useful in that it does not bind the roentgenologic examiner to extend his diagnosis beyond the limitations of his method of investigation.

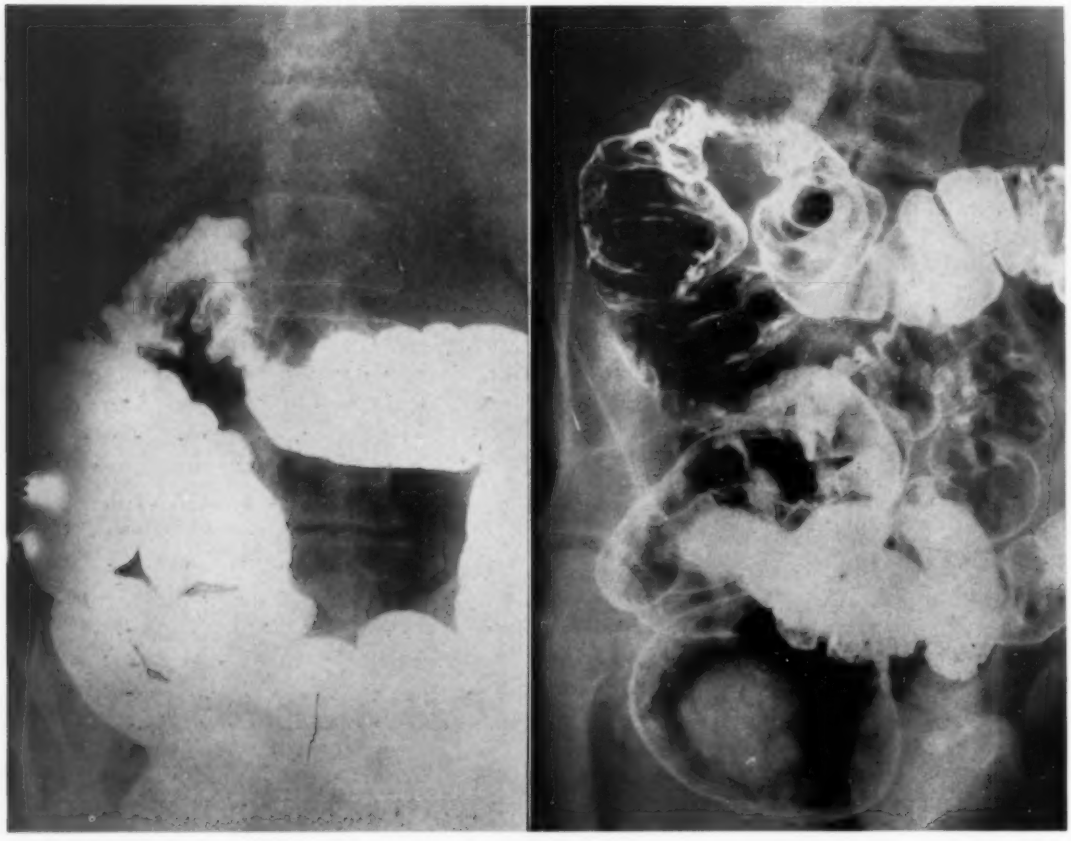

Fig. 5. Inflammatory (non-neoplastic) processes causing defects in the hepatic flexure. Left (opaque enema), pericolic abscess which proved to be secondary to perforating carcinoma of the gallbladder; right (double contrast method), pericolic abscess which proved to be secondary to perforating cholecystitis and cholelithiasis. The roentgenologic differential diagnosis between primary and secondary pericolic abscess is not readily made. Compare this roentgenogram and that reproduced in Figure 9.

It is sometimes possible, however, when all the etiologic types of inflammatory tumefactions are kept in mind, to offer what will often be no more than a reasonable guess as to the exact nature of the lesion at hand. A frankly defective yet useful tabulation of both the more commonly and the less frequently encountered inflammatory tumefactions is presented only to itemize the rather extensive list of etiologic possibilities (Table 1). The lesions are arranged in order of the frequency of their occurrence, in the experience of the Section on Roentgenology of The Mayo Clinic.

Table 1

NON-NEOPLASTIC TUMEFACTIVE LESIONS OF THE LARGE INTESTINE: INFLAMMATORY TUMEFACTIONS

A. Primary:
   1. Diverticulitis
   2. Tuberculosis
   3. Fibroplastic appendicitis
   4. Primary ileocolitis, typhlitis, pericolitis, and perisigmoiditis of unspecified etiology
   5. Streptococcic lesions
   6. Amebic lesions
   7. Actinomycotic lesions
   8. Very rare: syphilis, typhoid fever, anthrax, *Schistosomum japonicum* (*Bilharzia*)

B. Secondary to:
   1. Extension of inflammatory processes from adjacent or contiguous abdominal organs: gallbladder, female pelvic organs, seminal vesicles, omentum
   2. Segmental injury (foreign bodies, coproliths, circulatory disturbances)

Diverticulitis is the most commonly encountered of all inflammatory tumefactions. It is definitely a disease of older life, seeming to occur most frequently in persons of hypersthenic habitus who lead a sedentary type of life. Diverticulitis is the result of inflammation of one or more diverticula. The mere presence of diverticula is not of particular clinical significance. They occur in all parts of the gastrointestinal tract, but more of them are found in the colon, especially in its distal segments, than elsewhere. Diverticulitis occurs practically only in the sigmoid and lower descending segments of the colon. In the early stages the pathologic changes are local and are recognizable roentgenologically only by minor changes in the relief pattern of the regional mucosa. The adjacent inflammation may induce an exaggeration of the relief, or the relief may be subdued by flattening, resulting from submucous swelling and edema.

As the inflammatory process increases in severity and extent, a filling defect of more or less pronounced proportions develops. Spasm contributes considerably to the constriction, but encroachment on the lumen by the swelling, edema, and pericolic inflammatory tissue, is responsible for most of the narrowing. Usually a relatively long segment of the sigmoid colon is involved. The margins of the narrowed lumen have a serrated appearance: the constriction is concentric with the involved intestinal lumen, and its mucosal relief, while variably disturbed, is never obliterated entirely. Proximally and distally the filling defect tapers off into normal contours (Fig. 6). The appearances of the lesion may be modified by the administration of antispasmodic drugs until full physiologic effect is obtained, and by treatment directed at relieving the inflammation. The patient often complains of marked tenderness over the region affected. Manipulation of the inflammatory mass reveals that it is fixed, to some extent at least, but not inflexible. Palpation is usually vigorously resisted by the patient, and the pain caused by distending the constriction with the contrast enema is one of the most suggestive roentgenologic signs of this and other types of inflammatory lesions of the colon. The presence of uninflamed diverticula in distant segments of the bowel suggests the idea of diverticulitis in any given tumefaction of the distal colon, but it is important to remember that other lesions may be found coexistent with diverticulosis.

Hyperplastic intestinal tuberculosis is distinctively a disease of the ileocecal coil, although other segments, especially the sigmoid and hepatic flexures, may be involved (Fig. 7). This type of intestinal tuberculous lesion, unlike the ulcerative type, is not uncommonly primary in the

intestine and is thought by many to be caused by the organism of bovine or avian tuberculosis. It is prone to occur in young people. It is recognized grossly by the typical tuberculous nodules on the serosal surface or by regional tuberculous lymph nodes. Simultaneous involvement of cecum and terminal portion of ileum in a granulomatous mass constitutes a gross pathologic syndrome which usually, but by no means always, signifies a tuberculous etiology. It is this syndrome which affords the best differential diagnostic clue at roentgenologic examination. Ulceration, which may or may not be a prominent feature, is almost always present in some degree, and is manifested roentgenologically by changes in the mucosal relief corresponding to the depth of the ulceration. Compared with the internal relief pattern of other ulcerative non-neoplastic tumefactions, that of the tuberculous tumor is markedly nodular and uneven, but this circumstance cannot be said to have important diagnostic significance. In fact, there are no really satisfactory roentgenologic differential criteria by which the tuberculous tumefaction can be distinguished, except, of course, a coexisting active focus in the lungs or elsewhere, in which event any obviously non-neoplastic process in the ileum or colon is presumed, not altogether logically, to be of tuberculous origin.

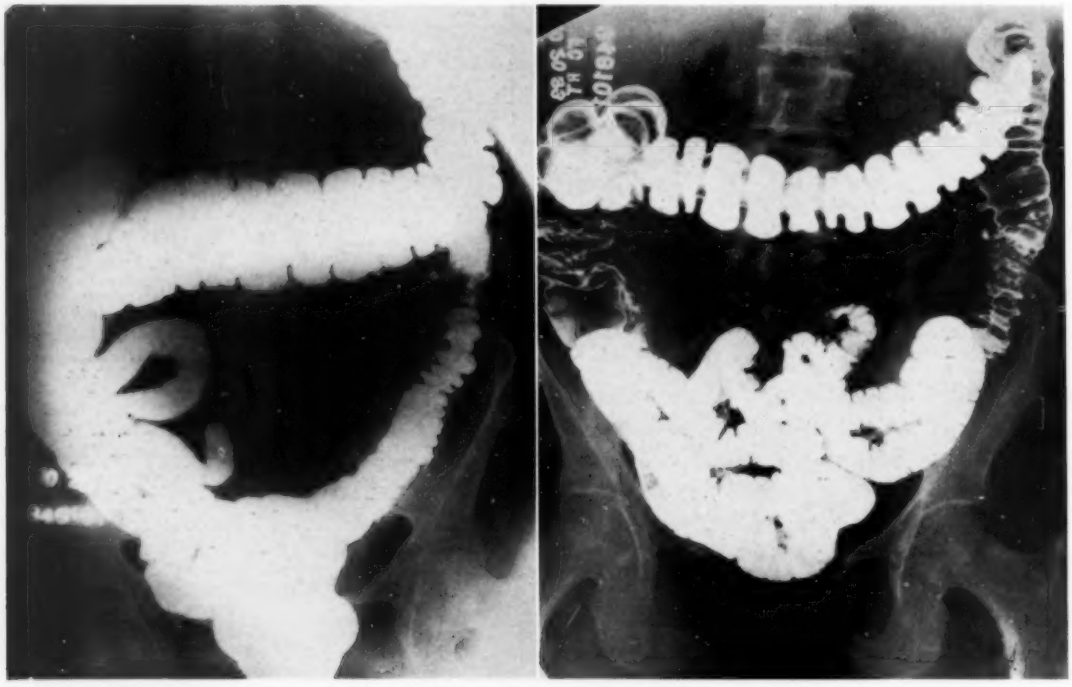

Fig. 6. Diverticulitis. Opaque enema (left); double contrast method (right). The filling defect is situated at the level of the crest of the left ilium. It has a typical roentgenologic appearance, but its location is unusually high in the descending colon. Roentgenologic diagnosis was verified at operation.

The amebic inflammatory tumor (Fig. 8), to which Gunn and Howard called attention, the actinomycoma, the cecal inflammatory tumor developed in association with so-called fibroplastic appendicitis, and primary ileocolitis and typhlitis, are lesions so similar to each other and to the tuberculoma in almost all details of their gross and roentgenologic appearance, that an independent roentgenologic differentiation between them seems hopeless. They are all preëminently diseases of the proximal part of the colon, often with combined involvement of the terminal portion of the

ileum and the cecum. True, the demonstration of the pathognomonic "sulphur granules" will establish the diagnosis of actinomycoma, and the presence of *Endamoeba histolytica* in the stool in association with any non-neoplastic tumefaction is diagnostic, by inference at least, of the amebic nature of the lesion, but these are not always available. Careful analysis and correlation of all pertinent clinical and roentgenologic data will often yield the complete diagnosis. It happens frequently enough, however, that the final diagnosis is not attained until opportunity for microscopic examination of the lesion presents itself.

Fig. 7. Ileocecal tuberculoma (roentgenologic diagnosis verified at operation). The cecum is diffusely narrowed and shortened, and the very distal segment of the ileum is slightly deformed. Left, opaque enema; center, after evacuation of the opaque enema; right, after insufflation (double contrast method).

Chronic streptococcic ulcerative colitis may very rarely be localized to a very short segment of the colon, and when this happens it presents a lesion which might be looked upon as an inflammatory tumefaction.[1] Again any portion of the colon may be involved. The lesion has all of the general characteristics of ulcerative colitis except that it is not diffusely spread over a large portion of the colon. The constriction is tubular in character, regular in outline, more or less fusiform in shape. The contours are smooth, and the internal surface is granular in appearance and entirely devoid of relief corresponding to the diffuse local denudation of the mucosa. Lesions having these characteristics are looked on as being essentially of the same nature as chronic streptococcic ulcerative colitis, in view of the fact that this diagnosis was verified at surgical exploration in several instances. In a few other instances a pathognomonic proctoscopic picture of this disease, not present at first, developed at a later time.

An inflammatory tumefaction of the colon occurs which is in no way associated with diverticula, tuberculosis, or any other known etiologic factor. Braun and Tietze[2] dealt exhaustively with inflammatory tumors of this kind in their excellent monographs. The lesions are pericolic in situation, apparently having the cecum and ascending and sigmoid segments as sites of preference. They are considered to be infectious in nature, the usual portal of entry being provided by local injuries to the mucosa. Whatever the pathogenesis, a dense infiltrative inflammatory process is set up, involving the wall of the intestine as well as the adjacent omentum and regional mesentery. The lumen is usually

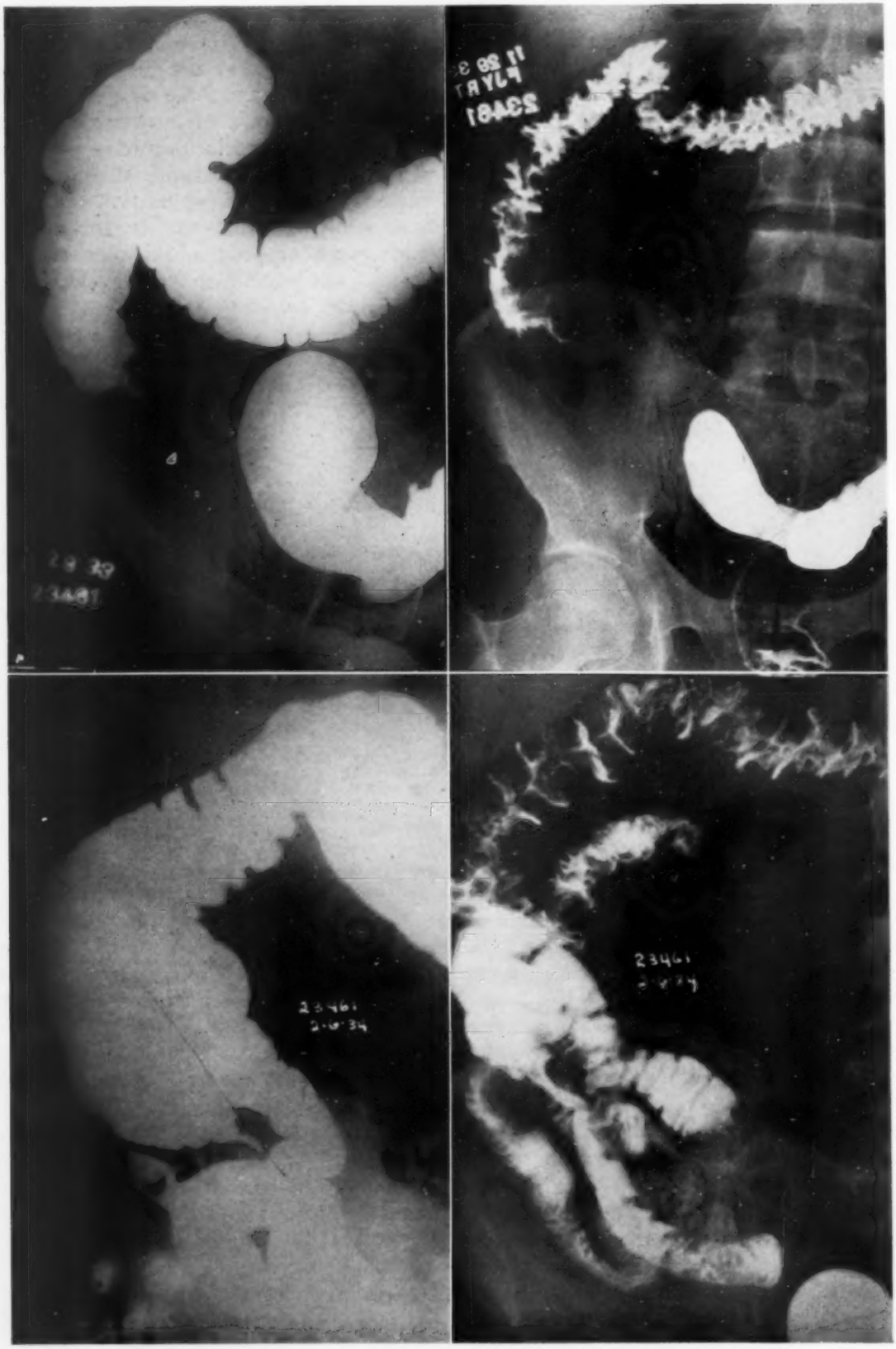

FIG. 8

considerably narrowed, often enough to cause obstruction, but the mucosa is left intact. From their serosal aspect these tumors resemble neoplasms so closely that many of them have been removed under the impression that they were carcinomas. The roentgenologic appearance of the filling defect produced is typical. It is a spindle-shaped deformity, longer as a rule than that of carcinoma, but lacking the rigidity and knotty induration of neoplasm. Close study of the internal relief reveals that the mucosa is relatively intact. The relief pattern differs from the normal only in that the relief is markedly exaggerated and shows more abrupt elevations and depressions than is usually observed in the normal (Fig. 9). The tumefactions caused by extension of inflammatory processes to the colon from adjacent or contiguous organs bear a close roentgenologic resemblance to these lesions (Fig. 5).

I have tried to make it apparent that the roentgenologic diagnosis of tumefactive lesions of the colon can no longer in any sense be considered empirical. It is based entirely on a syndrome of signs that reflects the gross anatomy of the lesion which produces them. The roentgenologic manifestations of any lesion are valuable only to the extent that they permit the interpreter to reconstruct a mental picture of the gross morphologic appearance and pathogenesis of the lesion at hand. Progress will result from diligent cooperation of roentgenologist, surgeon, and pathologist, and by continued comparisons of roentgenologic with gross pathologic findings. In general, the diagnostic efficiency of any individual examiner will be found to depend largely on his familiarity with the gross pathologic features of the lesions encountered and on the facility with which he correlates roentgenologic with pathologic data.

Fig. 9. Inflammatory tumor, of undetermined etiology, in the splenic flexure. The lesion disappeared entirely in a short time after cecostomy was performed.

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Fig. 8. Amebic granuloma. Left above (opaque enema) and right above (after evacuation of opaque enema) before antiamebic treatment (November, 1933). Left below (opaque enema) and right below (after evacuation of opaque enema) after antiamebic treatment (February, 1934). The cecal lumen was almost obliterated at the first examination. Some cecal deformity was still present at the second examination, but the affected portion was otherwise restored to normal.

ENCEPHALOGRAPHY IN NON-NEOPLASTIC INTRACRANIAL LESIONS*

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MEDICAL science was provided with a new and precise diagnostic method for examination of organic brain disease, with the introduction by Dandy of the cerebral pneumographic procedures, ventriculography[3] in 1918 and encephalography[4] in 1919. Although relatively recent, it has become one of the most important and widely used diagnostic methods in neurology and neurological surgery. It is our purpose in this communication to record our recent experiences in various non-neoplastic intracranial diseases.

INDICATIONS AND CONTRAINDICATIONS

Encephalography is a relatively simple procedure and herein lies its greatest hazard if employed indiscriminately. Its use as a diagnostic and prognostic method may reveal much sought for information in the convulsive states, mental deficiencies, birth trauma, psychosis, neoplasm (unassociated with increased intracranial pressure), and in degenerative and inflammatory diseases of the brain. It should be superfluous to state that a careful neurological study must be made before encephalography is attempted. It is usually contraindicated in all cases with a spinal pressure of over 20 mm. of mercury or its equivalent 280 mm. of water pressure in the horizontal position; in the presence of papilledema or of roentgen signs of increased intracranial pressure revealed as exaggerated convolutional markings, diastasis of sutures or pressure erosion of the sella turcica. Patients at the extremes of life, the very young and the very old, stand the procedure poorly. It is obvious that encephalography is not an entirely harmless method of diagnosis and should only be employed in the presence of definite indications with due consideration to the patient's general condition.

THE NORMAL ENCEPHALOGRAM

It is only as we appreciate and understand the normal cerebral patterns that we can realize the full potentialities of this pneumographic procedure in the interpretation of pathological intracranial processes. The Committee on the Standardization of Encephalography[27] has given a clear-cut description of the findings in the normal encephalogram. Torkildsen and Pirie[31] have analyzed the different components of the ventricles, particularly the lateral, responsible for the shadows as seen in ventriculography and encephalography. Dyke and Davidoff,[6,7,8,9] in their careful and minute studies of the normal appearances of the choroid plexuses, corpora quadrigemina, subarchnoid cisterns and the cerebral sulci and convolutions, have made extremely valuable contributions, which have added much to our knowledge of the encephalographic appearances of the finer normal cerebral structures. One is amply repaid for painstaking study of the normal and its comparison with the pathological.

The technique varies slightly from one institution to another and each modification has its staunch advocates. Disregarding these unessential minor variations in technique, the consensus seems to be that every effort should be made to obtain complete drainage of the ventricles and subarachnoid spaces and to replace the cerebrospinal fluid with air by rotation of the head, straining, coughing and jugular compression.

The method used at the New York Neurological Institute as described by Davidoff and Dyke[5] is essentially as follows: The first film is taken in the upright posteroanterior position after 25 c.c. of fluid has been removed and 20 c.c. of air injected. From this film they can determine

* The authors are grateful to Dr. Foster Kennedy and his staff for their cooperation in the preparation of this paper.

the amount of fluid to be withdrawn and when the ventricles appear normal in size, they inject only from 50 to 70 c.c. of air. Patients with larger ventricles require larger amounts of air but no more than 140 c.c. of air is ever injected. Manipulation of the head during the injection of air is considered non-essential. A total of sixteen stereoscopic views is taken, both horizontal and upright in the posteroanterior, anteroposterior and lateral positions, thus compensating for the smaller amounts of air used and thereby obtaining all the information desired. This procedure is followed because in their experience they have found that the "number and severity of symptoms both during and following encephalography are directly proportional to the quantity of air that has been injected."

The technique used at Bellevue Hospital for the past six months consists of preliminary sedation with a barbiturate, avertin anesthesia according to body weight and the use of oxygen instead of air. The other usual procedures are followed. The sedation and avertin anesthesia result in fewer immediate symptoms and afford greater ease in handling the patient. We have been convinced (as have others) that the use of oxygen, rather than air, gives rise to fewer post-injection symptoms and that oxygen disappears at a much earlier time after injection from the subarachnoid and ventricular tracts.

Encephalography at best is an unpleasant experience for the patient and all precautions should be taken to avoid inconclusive and unsatisfactory results by adherence to a standardized technique and proper positioning of the head during exposures.

ERRORS IN TECHNIQUE

To show the architecture of the patient's skull, to reveal fractures, localized areas of bone destruction and to avoid confusing shadows, the usual routine films of the skull should be taken prior to encephalography. It is important to center the head exactly to prevent distortion and erroneous displacement from the midline.

Subdural air is to be interpreted as an error in technique, the air being introduced into the subdural space instead of the subarachnoid space. The other alternative explanation is a rupture at the point where the arachnoid granulations pierce the dura, allowing the escape of the subarachnoid air into the subdural space.

In about 5 to 10 per cent of the cases, the ventricles are not visualized, even though all precautions are taken. This is to be regarded also as an error in technique. Occasionally, films taken twenty-four hours later may reveal partially filled ventricles, which would rule out an obstruction at the foramina of Luschka and Magendie. If feasible the procedure should be repeated, as in many cases the ventricles are demonstrated in a second examination. The explanation for non-visualization of the ventricles has been suggested by Bateman[2] as due to a membrane, non-permeable to air, at the basal foramina. Some anatomists believe that these foramina described by Luschka and Magendie are not real and assert that these are traumatic artefacts. Other explanations are increased intracranial pressure of variable etiology or a real pathological basal occlusion, a diagnosis which is justified only after a *ventriculogram* demonstrates an internal hydrocephalus.

The filling of only one lateral ventricle should also be regarded as an error in technique except in the presence of unquestionable clinical findings or a midline shift. Here also a roentgenogram taken the next day may show filling of the previously non-visualized ventricle.

DIAGNOSTIC CRITERIA

In the interpretation of the encephalogram we must consider the ventricles, the cortical subarachnoid markings or sulci and the basal cisterns. The greatest portion of the cerebrospinal fluid is absorbed in the parietal and frontal regions by the subarachnoid villi and the pacchionian bodies. Normally, fine cortical markings representing air in the sulci between convolutions

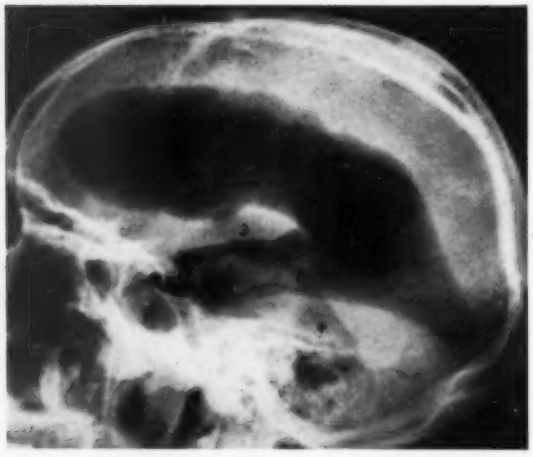

Fig. 1. Internal hydrocephalus in a man, aged thirty-five, clinically considered to be due to luetic meningoencephalitis. Note absence of cortical markings, dilated third ventricle (3), aqueduct of Sylvius (*S*) and fourth ventricle (4).

are present over this area. Cerebrospinal fluid is rarely found normally over the temporal or occipital lobes or beneath the frontal lobes, according to the work of Weed.[33] Pathologic processes that fill the cortical pathways with reactive materials (blood or inflammatory products) by interfering with the eliminating mechanisms will cause a stasis with a pressure atrophy of the cortex; dilatation occurs first in the subarachnoid spaces, then the basal cisterns and finally affects the ventricles. There is an increase in the size of the subarachnoid spaces over the frontal and parietal regions with the formation of compensatory pathways over the parietal and occipital lobes and enlargement of the basal cisterns, particularly the cisterna venae magnae cerebri. This particular picture described above is usually spoken of as cortical atrophy or external hydrocephalus and may be slight, moderate or severe; localized, unilateral or bilateral; may or may not be associated with an internal hydrocephalus. Similar results will be found in any loss of cerebral substance, localized, unilateral or bilateral from whatever cause.

"Arachnoiditis" or "arachnitis" is a term used to denote a localized, unilateral or complete absence of cortical markings. If errors in technique can be excluded, it signifies a lack of drainage and failure of air to displace the fluid (if present) in the region involved. The actual cause may be adhesions, obstruction to drainage below thereby trapping the fluid, pressure obliteration, change in the consistency of the cerebrospinal fluid or to some unknown hydrostatic or vascular factor. The history, or if indicated, an operation, may determine the cause, although many of these cases show no demonstrable pathology at operation.

In the presence of arachnitis one should guard against the diagnosis of atrophy, although the presence of dilated ventricles, cisterna and compensatory pathways and an increase in the amount of cerebrospinal fluid drained off is very suggestive.

When the lateral ventricles begin to dilate as a result of a loss of cerebral substance or from hydrostatic pressure, the upper and outer poles of the anterior horns lose their angular or pointed appearance in the anteroposterior view and become blunted or oval. This is the first sign of an internal hydrocephalus (Fig. 1). Asymmetrical atrophy of the brain may lead to a corresponding unequal or asymmetrical dilatation of the ventricles and subarachnoid channels. Meningocerebral adhesions will tend to pull the ipsolateral ventricle to the side affected while extensive subdural or subarachnoid accumulations of fluid or blood and mass lesions will cause a displacement to the opposite side.

The basal cisterns have a fairly constant pattern and are usually visualized. They are named, as a rule, according to the structures which bound them and are termed cisterna chiasmaticus, pontis, interpeduncularis, venae magnae cerebri, corporis callosi and fossa Sylvii. In describing them we note visualization or non-visualization, enlargement and distortions or encroachments.

Aplasia or agenesis cannot be differentiated from regional atrophy by encephalography and must be done clinically (Figs. 2 and 3). If there is, however, a history of

cerebral malfunction from birth or early childhood, the interpretation could then be that of aplasia of the brain.

In classifying our encephalographic findings we have attempted to decide whether they are within normal limits, whether cortical atrophy, scars, arachnoiditis or ventricular changes such as hydrocephalus, asymmetries, distortions and displacements are present. The size of the basal cisterns was not interpreted as of any significance except when greatly enlarged and in such cases they were usually associated with other findings. We have been conservative in our interpretation and have avoided overemphasizing doubtful findings. We have also grouped and graded the encephalographic findings, modified somewhat from that suggested by Gurdjian and Jarre.[16]

Group I—Graded 0—Normal encephalographic pattern.

Group II—Graded 1—Moderate encephalographic evidence of disease.

Group III—Graded 2—Marked encephalographic evidence of disease.

Group IV—Graded 3—Marked encephalographic evidence of disease (the extent of the pathological process and perhaps the proper diagnosis could only be demonstrated by this method).

We concede the fact that severe incapacitating cerebral disease may exist with normal or slight variations from the normal findings in the encephalographic silhouette and that the converse, mild cerebral symptoms with marked changes in the encephalogram, may occur. Notwithstanding this, if we have carefully selected the cases with the proper indications, the grouping should prove useful as a future guide in this work to obviate the use of encephalography in patients with a clear-cut clinical diagnosis and promising little or no additional information from this source.

We have studied 105 cases of various intracranial conditions including idiopathic epilepsy, schizophrenia, degenerative, inflammatory and vascular lesions, and posttraumatic conditions such as convulsive states, subdural hematomata and posttraumatic headaches.

Fig. 2. Colored female, aged forty-three, presenting neurological and psychotic manifestations, but no abnormal cerebellar signs. Encephalography reveals circumscribed accumulation of air in the posterior fossa beneath the tentorium and posterior to a rudimentary or displaced cerebellum.

In the group of idiopathic epilepsy are included those with convulsive states with no history of trauma, without clinical or serological evidence of lues and with brain

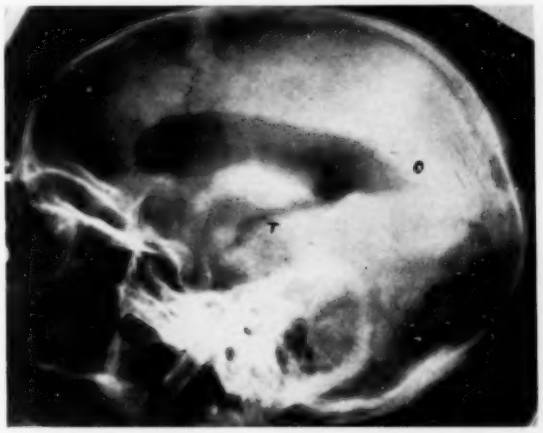

Fig. 3. Same patient as in Figure 2. Ventriculogram reveals upward displacement and compression of the temporal (*T*) and occipital (*O*) horns. A tentative diagnosis of cerebellar cyst or possibly partial agenesis of the cerebellum was considered.

tumor eliminated clinically and by the injection of air. In our 30 cases, 14 were classed as normal; in 4 cases the ventricles were not visualized, 2 on two examinations and 2 on one examination; 12 cases were pathological, revealing cortical atrophy of various degrees either alone or associated with other findings such as internal hydrocephalus, ventricular distortions or asymmetries and arachnoiditis. There were no cases of cortical scars or displacement of the ventricular system and 6 cases showed focal neurological signs. In grading our findings 26 was scored out of a possible 90, a rating of 28.8 per cent.

Numerous encephalographic studies of idiopathic epilepsy have been made with considerable difference in results.

	Normal	*Pathological*
Notkin[23]		
17 cases	8	9
Stone and Jones[29]		
27 cases	17	10
Winkler[34]		
78 cases	47	31
Grant[15]		
72 cases	25%	75%

Some investigators have reported encouraging results with the therapeutic drainage of the cerebrospinal fluid and its replacement with air, but the relief, if obtained, has only been temporary. The dilatation of the subarachnoid spaces with an increase in the cerebrospinal fluid and disturbed fluid elimination is the basis for Fay's[13] dehydration method of therapy in epilepsy.

In our series there has been no constant correlation between the encephalographic picture and the clinical manifestations of epilepsy. Severe and incapacitating epilepsy was often associated with a normal or moderately abnormal encephalogram and mild grades of epilepsy might show marked changes in the encephalogram. The pathological findings, consisting of various degrees of cerebral atrophy associated with or without internal hydrocephalus, asymmetries, or distortions of the ventricles, enlarged basal cisterns, were not characteristic or specific for idiopathic epilepsy but were found in other widely diverse clinical entities as cerebral arteriosclerosis, mental deficiencies, encephalitis and post-encephalitic Parkinson's disease, schizophrenia, etc., and sometimes even in patients with no demonstrable disease of the central nervous system.

In considering cases with possible traumatic etiology, one must exclude infectious, inflammatory diseases, sequelae due to vascular accidents and congenital malformations. Furthermore, a history of adequate trauma must be elicited. Kennedy[17] gives the criteria of head injuries sufficient to produce organic changes in the brain as follows:

Absolute Criteria

1. Roentgen evidence—skull fracture
2. Bloody spinal fluid
3. Bleeding from orifices, especially the ears
4. Focal cerebral palsies

Presumptive Criteria

5. Convulsive states proved to be post traumatic
6. Ventricular distortions proved to be post traumatic
7. History of prolonged unconsciousness
8. History of adequate trauma with especial consideration to the occurrence of vomiting following the injury.

The first four units together with the 7th and 8th can be determined with accuracy. Convulsive states are often complained of but not readily seen. One may satisfy oneself of their reality by provoking an attack in many instances by cocaine or hyperventilation. This incidence is of value when positive. Headache and dizziness are well nigh imponderable factors after head injury. However, if they persist for more than four months in a man under sixty, ununited to any of the first seven premises of brain injury they are to be regarded as suggestive neurosis unfounded on structural change.

There are probably several factors which are responsible for the changes seen in the encephalogram in traumatic cases. Bagley,[1] Weed,[32] and Wortis,[35] agree that blood in the cerebrospinal fluid causes a disturbance in the fluid eliminating mechanism even in the absence of meningocortical adhesions.

Osnato and Giliberti[24] and Martland[21] have reported multiple, minute intercerebral hemorrhages as well as perivascular hemorrhages in traumatic encephalopathy in which the spinal fluid was clear. In addition to subarachnoid bleeding and the microscopic hemorrhages, there may be gross epidural or subdural and intracerebral lacerations and hemorrhages. In intracerebral laceration with retention of products of injury (Fig. 4), there is a removal of the injured tissue by phagocytic action of the microglia with a formation of meningocerebral adhesions and contracting cerebral scar as reported by Penfield, Wortis,[35] Stevenson,[28] and others.

Porencephalies are wedge- or funnel-shaped defects of brain with a membrane-like sac and filled with a colorless fluid. They extend from the cortex in close proximity or communicate with the lateral ventricles and are usually post-traumatic, although some authors postulate a congenital etiology.

From the diverse pathology and the different degrees of injury, it necessarily follows that the encephalographic evidences of post-traumatic disease may vary from a completely normal to a symmetrical or asymmetrical cortical atrophy with or without internal hydrocephalus or distortions of the ventricular system. Encephalograms of patients whose brain injury has been unilateral show the lateral ventricle much larger on the injured side and often pulled over to the injured side by meningocerebral adhesions and contracting cerebral scars.

Fig. 4. Bullet wound in the right temporofrontal region three years before examination. Encephalogram reveals generalized arachnoiditis, asymmetrical dilatation of ventricles and traction of the right anterior horn to affected side. Porencephalic cyst at site of trauma. Note bullet fragment (*B*) in temporal lobe.

Fig. 5. Man, aged thirty-eight, admitted to hospital in coma with a fractured skull. Treated conservatively but had recurrence of stupor with right hemiplegia. Encephalogram shows obliteration of sulci on the left side and air beneath the tentorium cerebelli (*T*). The presence of a subdural hemorrhage was verified by operation. Arrows indicate course of fracture.

In our traumatic cases the entire ventricular system was displaced to the opposite side in 3 patients—twice by a subdural hematoma and once by a large intracerebral hemorrhage. The time interval between the injury and encephalographic examination is important. Deviations from the normal may be visible in as short a period as one month and may be seen immediately in subdural hemorrhage or a large intracerebral laceration.

From a vast literature on encephalographic studies, particularly after brain trauma, we found that Dixon and Ebaugh[12]

FIG. 6. Female, aged fifty. Ligation of left internal carotid artery for a left-sided arteriovenous aneurysm of the cavernous sinus due to automobile accident. Optic atrophy on left side with blindness and a right hemiplegia developed. Encephalogram reveals asymmetrical internal hydrocephalus, more marked on left due to cerebral atrophy resulting from the ischemia following the ligation of the nutrient artery.

reported in 19 cases localized atrophy with ventricular dilatation on the side of injury; widened cortical sulci, separation of the medial longitudinal sulcus and generalized atrophy with increased fluid over the cortex. Pendergrass[26] gives essentially the same findings. Stone and Jones[29] report 25 cases with traumatic convulsive states, of which 13 were normal and 12 pathological. E. D. Friedman[14] studied 20 cases with a traumatic history and found deviations from the normal in 19 cases as follows: dilatation of the ventricles, considerable accumulation of air over the convexity of the brain and migration of the ventricular system toward the site of the lesion. These abnormalities were found either singly or in combination. Grant, in a series of 51 traumatic cases, found only 5 normal encephalograms. In 2 of his cases the larger ventricle was on the opposite side, due to the *contre coup* cerebral trauma.

Lindemulder[19] reports one case of subdural hematoma with obliteration of the subarachnoid spaces on the involved side, compression of the ipsolateral ventricle and dilatation of the opposite ventricle; the whole ventricular system being displaced past the midline to the opposite side. Figure 7 depicts the findings in a case from our series which closely correspond to those observed by this author.

We have studied a total of 33 traumatic cases: 16 have had convulsive states, 14 with traumatic encephalopathy, 2 with subdural hematoma and one case of extensive cerebral laceration and intracranial hemorrhage. In the 16 cases of convulsive states of traumatic etiology, 14 cases were pathological, 2 were normal; 11 cases were positive for fracture by roentgenography, 5 cases were operated on—3 at the time of injury and 2 subsequently; 11 cases showed focal neurological signs; 11 cases showed cortical atrophy, 7 arachnoiditis, 6 cerebral scars, 10 internal hydrocephalus, 7 asymmetry and distortion of the ventricles and 2 cases revealed porencephalic cysts. Out of a possible 48, 28 was scored, a rating of 58.3 per cent. The findings were similar but less marked in the cases of traumatic encephalopathy (see Table 1), the rating

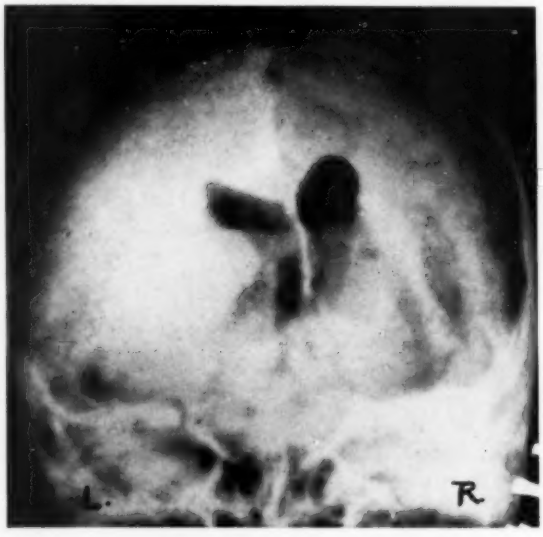

FIG. 7. Man, aged thirty, admitted to hospital in coma following an injury. Note deviation of the anterior horns to the right and distortion of the left side due to an intracerebral hemorrhage. Verified by operation.

Table I

	Diseases	Total Number of Cases	Normal	Pathological	Possible Score	Actual Score	Rating—Per Cent	Focal Neurological Signs	Cortical Atrophy	Arachnoiditis	Scar	Ventricles: Internal Hydrocephalus	Ventricles: Asymmetries and distortions	Ventricles: Displacements	Comments
	Idiopathic epilepsy	30	14	12	90	26	28.8	6	12	4	0	10	4	0	4 cases, ventricles not visualized; 2 cases on 2 examinations; 2 cases on 1 examination
	Schizophrenia	6	2	4	18	6	33.3	0	2	1	0	3	1	0	
	Encephalitis and post-encephalitic Parkinson's disease	8	3	5	24	7	29.1	7	2	1	0	4	2	0	
	Mental defectives	12	4	7	36	11	30.8	2	5	2	0	6	3	0	1 case, ventricles not visualized on 1 examination
	Cerebral arteriosclerosis with deterioration	7	1	6	21	10	47.6	2	6	1	0	5	0	0	
TRAUMATIC	1. Convulsive	16	2	14	48	28	58.3	11	11	7	6	10	7	0	11 cases positive for fracture by x-ray; 2 cases with porencephalic cysts
TRAUMATIC	2. Traumatic encephalopathy	14	3	10	42	17	40.4	7	9	4	2	8	4	0	1 case, ventricles not visualized; 5 cases, positive for fracture by x-ray
TRAUMATIC	3. Subdural hematoma	2	0	2	6	6	100	2	1	1	0	0	1	2	Both cases positive for fracture by x-ray
TRAUMATIC	4. Intracerebral laceration	1	0	1	3	3	100	1	0	1	0	0	1	1	Positive for fracture by x-ray
LUES	1. Meningovascular lues	1	0	1	3	1	33.3	1	1	0	0	0	0	0	
LUES	2. Perichiasmatic luetic meningitis and gumma	1	0	1	3	3	100	1	0	1	0	1	1	1	
LUES	3. Luetic hemiparesis	2	0	2	6	4	66.6	2	2	2	0	2	2	0	
	Alcoholic encephalopathy	1	0	1	3	2	66.6	1	1	0	0	1	1	0	
	Internal hydrocephalus (post meningitic)	2	0	2	6	4	66.6	0	?	0	0	2	0	0	Ventriculographic study
	Arteriovenous aneurysm of the cavernous sinus with ligation of internal carotid artery on affected side	1	0	1	3	3	100	1	1	0	0	1	1	0	See Figure 6
	Undiagnosed cerebellar cysts? cerebellar atrophy? aplasia?	1	0	1	3	3	0	0	0	1	1	0			See Figures 2 and 3

being 40.4 per cent. Cortical atrophy, ventricular enlargement and distortion and asymmetry were frequently most marked on the injured side. The outstanding finding, however, in the 2 cases of subdural hematoma and the case of intracerebral hemorrhage was displacement of the entire ventricular system to the opposite side (Fig. 7).

Encephalography has also been found

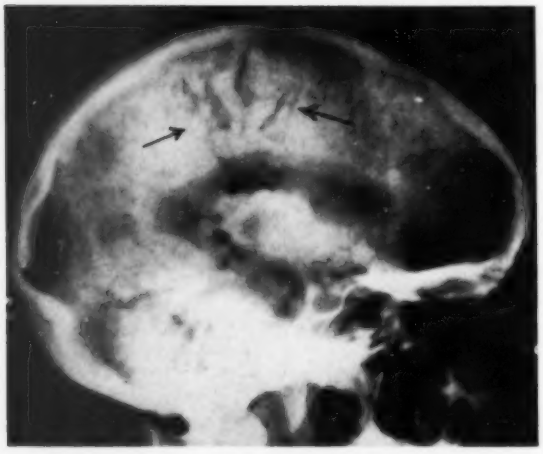

FIG. 8. Pugilist, aged twenty-nine, had been "knocked out" five years previously; mental and behavior symptoms gradually developed. Neurological examination suggested multiple cerebral lesions. Encephalogram reveals regional cortical atrophy (see arrows) of the post-central gyri and moderate internal hydrocephalus.

useful in many other neurologic conditions and in the psychoses. Moore[22] and his associates report the findings in 60 selected cases of schizophrenia, none of which showed a normal encephalogram; the encephalographic changes reflected a distinct correlation between the amount of atrophy and the degree of mental deterioration (Figs. 8 and 9). Stone and Jones[29] found 5 pathological encephalographies in 7 cases with encephalitis and post-encephalitic Parkinson's disease. McKhann and Vogt[20] report a case of lead encephalitis with cortical atrophy and moderate internal hydrocephalus.

Dixon and Ebaugh[12] give their conclusions from a study of 15 mental defectives as follows: "A variable picture with localized atrophy, unilateral and less frequently bilateral ventricular enlargement, dilatation of the basal cisterns, and marked convolutional atrophy with deepening and widening of the sulci."

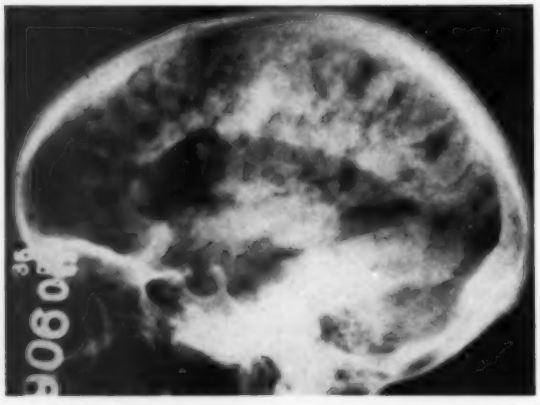

FIG. 9. Female, aged fifty-two. Neurological and psychotic manifestations due to cerebral arteriosclerosis with "deterioration." Blood and spinal Wassermann, negative. Encephalogram reveals diffuse coarseness of sulci and dilatation of the ventricular system, indicating marked cortical atrophy and internal hydrocephalus.

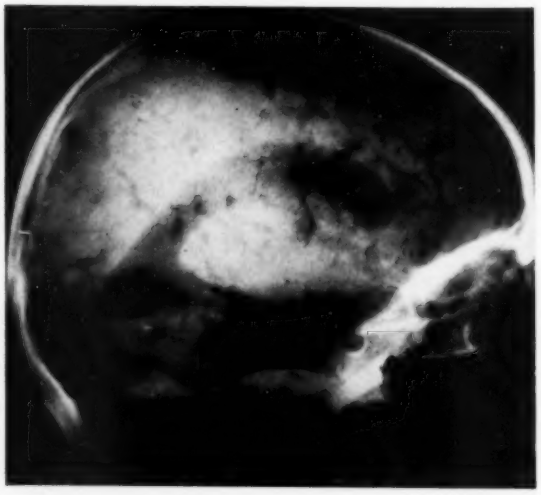

FIG. 10. Female child, aged five. Had pertussis eleven weeks previously, followed by encephalitis. Encephalogram reveals moderately coarse sulci in the frontal region and moderate hydrocephalus.

In vascular lesions the encephalographic silhouette tends to follow a vascular pattern, except for the cases of cerebral arteriosclerosis and meningovascular lues where the more diffuse pathology is mirrored in the encephalogram. Stone and Jones reported on the study of 8 cases of cerebral arteriosclerosis of which 5 showed cortical atrophy and one internal hydrocephalus; 2 were normal.

COMMENT AND DISCUSSION

The findings of cortical atrophy, internal hydrocephalus with enlargement of the basal cisterns, especially if symmetrical, is

not specific for any one brain disease and we have noted it in idiopathic epilepsy, mental deficiencies, cerebral arteriosclerosis, encephalitis (Fig. 10), post-traumatic encephalopathy, schizophrenia and meningovascular lues. In these and similar conditions, although the encephalogram depicts the gross pathology present, it is not specific and gives no information as to the possible etiology. Here we must note a definite exception, agenesis of the corpus callosum, recently reported by Dyke and Davidoff.[10]

At the present time deviations from the normal in the ventricular system are more reliable diagnostic criteria than are changes in the cortical markings. If the ventricles are normal, one should be hesitant to make a diagnosis of atrophy on slight variation in the cortical markings. No doubt, in the future we will be able to give more accurate and helpful interpretations of the pathology as demonstrated by the cortical markings, but at present we deem it wise to be conservative in our interpretation.

In our studies of non-neoplastic diseases we have found that encephalography has proved itself of most value in traumatic conditions, especially in those cases where operative intervention was being considered, i.e., in subdural hematoma, porencephalic cyst, post-traumatic scar with epilepsy, etc. It also was frequently of help in excluding the possibility of tumor in the absence of contraindications.

A normal encephalogram does not denote a normally functioning brain, and the opposite is also true, that an abnormal encephalogram does not necessarily indicate a disorder of mental or nervous function or its extent. The encephalogram in itself cannot be taken as a measure of function but must be correlated with the history, psychiatric and neurologic findings, each method aiding in reaching a diagnosis and in expressing a probable prognosis.

CONCLUSIONS

1. Encephalography is a useful diagnostic procedure in non-neoplastic diseases—but must be correlated with other clinical findings, i.e., it is not usually a diagnosis per se.

2. There is no specific or characteristic encephalographic picture of any one non-neoplastic intracranial lesion. The following exceptions may be mentioned:

   (a) Traumatic cases usually show changes most marked on the injured side and subdural hematoma may displace the ventricular system to the opposite side.

   (b) Vascular lesions tend to follow a vascular pattern of distribution.

3. An encephalogram does not measure the functional capacity of the patient.

4. Encephalography is of most value in those non-neoplastic conditions where a surgical procedure may be contemplated or in those cases where a tumor is suspected.

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ROENTGEN SIGNS IN HYDROCEPHALUS AND THEIR DIAGNOSTIC VALUE*

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IN hydrocephalus craniography† as well as encephalography or ventriculography, reveals a number of changes both in the bones of the skull and in the cavities of the brain. These changes are manifold but not identical in all cases. In some cases of hydrocephalus we find changes in the sella turcica, in others there are no changes in it. When such changes take place, they assume one form in some cases and another form in other cases. In certain cases of hydrocephalus we find changes in the configuration of the bones of the vault of the skull and of its base without any changes in the relief of the internal plate and even with a decrease in details of that relief; in others we observe digital impressions, developed to a greater or smaller degree, and so forth. The object of the present paper is to explain the variety of roentgen signs in hydrocephalus, to point out the regularity of the causes producing them, to establish the connection between them both qualitatively and, if possible, according to the time of their appearance, and draw practical conclusions therefrom for determining the forms of hydrocephalus.

In explaining separate points of the roentgen diagnosis in hydrocephalus, we take into consideration the established physiological factors, the peculiarities due to age and the variations in the form of the skull and of its parts, and we give special attention to circumstances of a physical kind, namely, hydrodynamics, which play a decisive rôle in the origin of a number of signs revealed by the roentgen ray in hydrocephalus, which so far have not been sufficiently explained in papers dealing with this question.

† We call craniography, as distinguished from encephalography and ventriculography, the method of roentgen examination of the skull without the application of the contrast methods.

ROENTGEN DIAGNOSIS

In hydrocephalus we distinguish the following signs on the roentgenogram:

The Configuration of the Vault of the Skull. The form of the vault of the skull in hydrocephalus is determined by hydrodynamic influences which proceed from the ventriculi and which cause the skull to approach the ideal geometrical figure, i.e., the sphere. The radius of the vault of the skull increases, and since the invariable point of support (point d'appui) for the skull is one of the spots on its surface, namely, its junction with the atlas, the increase in size will remove the center from the point of support, i.e., the center of the vault will be displaced upwards. In a normal skull moderate contractions are often observed at the coronal and lambdoidal sutures (the connection of three skull vertebrae—the theory of the skull formation advanced by Goethe-Oken). In hydrocephalus these unevennesses become smoothed away and the line of the vault of the skull becomes more even. In some cases of hydrocephalus a considerable elongation of the skull is observed, while its frontal section remains round. The latter is observed on sagittal roentgenograms. Marked changes in the configuration of the cranium and its base, observed on the roentgenogram, will naturally appear only in cases of hydrocephalus in children, the more pronounced the earlier hydrocephalus has begun and especially pronounced in congenital cases. These changes will be less pro-

* This paper was read in 1932 at the Scientific Conference of the Neuro-Surgical Institute and at the Society of Roentgenologists in Moscow. Many suggestions contained in this work appear for the first time. They are being worked out and checked under the supervision and immediate participation of Prof. Burdenko.

nounced in cases where hydrocephalus begins at a later age, when the skull is fully formed, and in rare instances and to a small degree are revealed in the skulls of adults, but after a considerable duration of the affection.

The Configuration of the Cranial Fossae. The same phenomena are observed in the cranial fossae in the form of their extension, their flattening and an increase in their radii. At the same time the level of the posterior part of the anterior cranial fossa, i.e., the small wings, shows a tendency toward a relative lowering, while the anterior part of the fossa tends to rise.

The Level of the Parts of the Base and the Basal Angle. The body of the basal bone, the sella turcica and the apices of the pyramids are lower. Those parts that are farther away from the point of support have a tendency to rise. This explains the drawing closer together of the level of the sella turcica and the external auditory canal as it is observed in the lateral roentgenogram of the skull.

The basal angle is increased from its normal of 130–140°. This angle is liable to great variations on the roentgenogram—an incorrect position of the head or the deviation of the central ray from the plane of the cranial base may give an erroneous idea.

The Size of the Skull. The size of the skull greatly increases. This sign is less obvious in the roentgenogram than it really is and is liable to great variations due to roentgen technique.

The Thickness of the Bones. The bones become thinner, sometimes to a very striking degree. In those instances a roentgenogram is often misleading, namely, representing the bones thicker than they are, especially in the lateral view, where the superimposed ridges of the longitudinal and transverse venous sinuses create a wrong impression.

The distention of the sutures is to a larger or smaller degree observed in the roentgenogram. In some cases the distention of the sutures leads to the stretching of the dentation, which becomes as it were parallel-striped, the hiatus of the open suture remaining relatively small. In other instances there is observed a more obvious distention of the suture, which becomes gaping, but there is no marked stretching of the dentation.

In the roentgenogram of the base of the cranium an increase in the size of openings and passages is noted.

In hydrocephalus, the relief of the bones in the roentgenogram is, in some cases, very complicated, in others, we find the relief of the bones poorer in details. How can this be explained? The brain, both externally and internally, is embraced by a single connecting system of fissures and canals filled with fluid, in which the brain is as if suspended. The pressure in the whole of this system is balanced and, according to the law of Pascal, is equally transmitted in all directions on each unit of the surface of the wall of the closed vessel. So long as the inner surface of the skull bones is separated from the surface of the brain, be it even by a thin connected layer of fluid, the pressure is equally transmitted by the fluid. In such cases of hydrocephalus, the bones bear an equal pressure at each point of the surface and therefore no alterations in the relief of the inner plate will take place—or perhaps, only in the sense that the surface will be rendered more even and the relief will lose some of its details. Other conditions arise in cases where the subarachnoid space becomes poorer in fluid and this space grows narrower. In such circumstances the most convex spots of the gyri will come nearer to the bone, and being separated from it only by the membranes will directly transmit the pressure, while in the sulci the fluid will be preserved. This explains the appearance of digital impressions, which are the impressions of the salient part of the brain convolutions. In the posterior cranial fossa on the subtentorial part of the occipital bone, as far as the surface of the cerebellum has another relief, there can be no relief similar to the digital impressions, even in craniostenosis.

A higher intracerebral pressure, which in hydrocephalus produces a development of digital impressions, leads—if the size of the ventricles is increased—to the thinning of the cortical layer, the smoothing of its surface and therefore to conditions which produce contrary changes: the inner surface of the cranial bones becomes more even and in the latter stages of a very sharp and early developed hydrocephalus, the former digital impressions again become moderately smoothed away.

Apart from this, a stronger pressure of the brain cortex against the bone, which takes place in certain forms of hydrocephalus, leads to changed conditions of the venous return flow, i.e., to squeezing of the venous channels and appearance of deeper impressions of them on the osseous wall. In turn the squeezing and the constriction of the lumen of the veins, especially the venous sinuses in the base, and the pressure near the jugular opening leads to venous stasis and to the development of collateral circulation through the diploic veins and the veins of cranial and facial coverings. The above circumstances explain the greater complexity of the relief of the skull bones in certain forms of hydrocephalus. In such cases we observe deeper furrows of the venous collectors (sinuses): oblong, transverse and sigmoidal, sinus sphenoparietalis and their lacunae, as well as developed emissaries, imprints of meningeal arteries and diploic veins.

The mere enumeration of all these changes in the bones of the skull in hydrocephalus, the variety of roentgen signs urges us to group them and to explain them in connection with definite forms of hydrocephalus, therefore a sign of such importance as the form of the sella turcica can and will be considered by us only when examining and coordinating the roentgen signs of separate kinds of hydrocephalus.

The Anatomical and Physiological Theories. At the present time the majority of authors hold that normally cerebrospinal fluid is produced chiefly in the ventricles by the choroid plexus and perhaps by the ependyma. The fluid is resorbed mainly in the subarachnoid space by the veins by means of the pacchionian bodies (Dandy, Weigelt, Becher, Nonne, Weed).

The displacement of the fluid from the lateral ventricles through the foramina of Monro from the third ventricle through the aqueduct of Sylvius to the fourth, and finally, through the foramina of Luschka and Magendie to the cisterna magna takes place apparently owing to the rhythmic vibrations of the brain, depending on the amount of blood in its vessels during systole and diastole (Becher, Weigelt). Monakow's opinion (1921) as to the possibility of a perivascular, parenchymatous passing of the fluid from the ventricles to the subarachnoid space was not confirmed by subsequent experiments. Thus, the fluid accumulates in the basilar cisterns (cisterna magna, pontis, interpeduncularis et chiasmatis).

Its subsequent progress in the subarachnoid space towards the vault and through fissura Palii towards the pacchionian bodies situated above has not been proved, but there are serious grounds for supposing that it actually takes place. Though the German physiologists failed to establish this fact, the American authors, Pancoast and Fay, are of the opinion that the fluid ascends from the cisterns.

We believe that the progress of the cerebrospinal fluid is determined by several causes, namely, by the changes in the volume of brain at pulsations, by the elastic tension of the brain tissue and membranes, by hydrostatic conditions and by the laws of capillarity.

Weed believes that 90 per cent of the fluid is absorbed by the pacchionian bodies in the skull and only 10 per cent descends into the spinal space.

The pressure of the cerebrospinal fluid in the cisterna magna in a sitting position is somewhat lower than the atmospheric pressure (Eskuchen).

Harkawy believes that this pressure gives a negative figure in the upper part of the cistern and becomes positive in the lower part. In the spinal space these figures increase in the downward direction owing to the hydrostatic factor, to the elasticity of membranes and tissues and to the influence of the blood pressure.

There are reasons for supposing that the pressure upward from the cisterna magna is correspondingly reduced, both in the ventricles

and the subarachnoid space, when a person is standing or sitting, and can be at normal lower than the atmospheric pressure.

In pathologic cases the proportion of production of the cerebrospinal fluid in the ventricles with its resorption in the subarachnoid spaces, as well as the freedom of

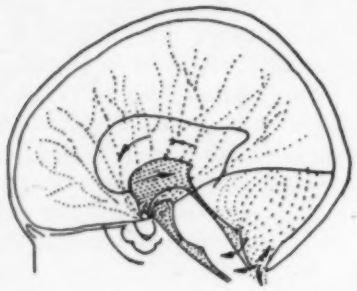

FIG. 1. A diagrammatic outline of the paths of communication of the cerebrospinal fluid in the ventricles, in the large basilar cisterns and in the subarachnoid space.

its movement along definite paths from the first to the second or the difficulties along these paths of communication determine the forms of hydrocephalus.

We distinguish an open form of hydrocephalus: (*a*) with the prevalence of hypersecretion; (*b*) with the presence of nonresorbent phenomena, and a closed form of hydrocephalus.

Let us examine each of these forms according to the above noted roentgen signs for the purpose of bringing out the roentgen signs peculiar to each kind, if such signs are found.

Open Hydrocephalus. In each type of open hydrocephalus we can have, in children, all the above-mentioned characteristics of configuration of the hydrocephalic roof of the cranium and the fossae: the thinning of bones; the distention of the sutures more often after the type of elongated dentation with a small gaping fissure in the suture; in certain cases there can be an increase in the angle of the base. When it is greatly increased the levels of the pyramids and of the sella turcica come closer together. Owing to the free inflow of the surplus amount of fluid from the ventricles into the subarachnoid space and its accumulation there, due to an insufficiently rapid resorption, the digital impressions in cases of open hydrocephalus with hypersecretion have no cause for development—they never appear in roentgenograms, provided that an open form existed throughout the whole period of illness. On the contrary, the relief of the bones of the cranial vault in that form of hydrocephalus is smoothed over and is poor in details. Not only do we fail to see in it any digital impressions, but it does not contain either sharply outlined venous sinuses or arterial and venous furrows.

The sella turcica experiences equal hydrodynamic pressure from above, from the direction of infundibulum of the third ventricle as well as from the direction of the surrounding cisterns, whose fluid, connected with the ventricles when there is an open hydrocephalus, transmits to the sella a pressure equal from all sides (Fig. 1). These pressures from the direction of the ventricles and the cisterns are applied in opposite directions and largely neutralize

FIG. 2. M., female, aged seven. Sharply expressed signs as regards the form of the skull, the thinning of the bones, the distended sutures, there being no digital impressions and no change in the sella turcica, establish hydrocephalus of an open type. Encephalography confirmed the diagnosis and showed an enormous distention of the ventricles with a thin layer of cerebral tissue.

each other. Therefore, in the open form of hydrocephalus in children we observe usually an unaltered sella (Fig. 2), which circumstance is compensated for by marked changes in the vault and sutures. At a later age, when the vault of the cranium becomes less yielding, we may find a sella of a cup-like form with a dilated entrance, relatively shallow floor, parallel to the outlines of the middle cranial fossa, dilated in a similar way, and with low dorsum. The anterior clinoid processes can be somewhat lowered and pointed.

Encephalography in open hydrocephalus reveals a free passage to the dilated ventricles with rounded corners. In the subarachnoid spaces there is much air. In the basilar cisterns there is, in most cases, no air—it penetrates freely higher up.

In an open non-resorptive hydrocephalus with adhesive phenomena in the subarachnoid space, roentgenography gives us the same signs in the bones; encephalography, when there is the same picture of ventricles dilated with air, reveals the accumulation of air in the basilar cisterns and the absence or insufficient and uneven filling of the subarachnoid paths, the filling of which is rendered difficult (Figs. 3 and 4). It is necessary to use special care in interpreting these encephalograms because the penetration of air either in the subarachnoid or epiarachnoid space may give different pictures.

Fig. 3. O., male, aged ten. The bones of the skull have become thinner. The line of the oval of the vault is even (without "waists" on the coronary and lambdoid sutures). The fossae are wide. The anterior clinoid processes are lowered. The basal angle is large. The sella turcica is relatively unchanged. The sutures are broad. There are no digital impressions; the relief of the bones is smooth. Roentgenography establishes hydrocephalus of the open type and of long standing. Encephalography confirms the diagnosis, and owing to the absence of air in the subarachnoid fissures and its presence in the basilar cisterns, gives rise to the presumption of the possibility of non-resorptive conditions.

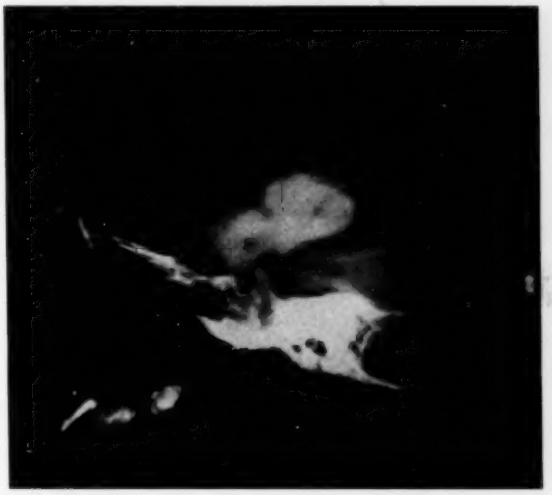

Fig. 4. S., female, aged nine. Roentgenography: the form of the vault, the thickness of the bones, the condition of the sutures, the intact sella turcica, the absence of digital impressions, establish hydrocephalus of an open type. Hydrocephalus has been developing not from the first years of life—the basal angle is not increased. Encephalography supplemented the diagnosis, establishing the possibility of non-resorptive conditions—the air has accumulated in the basilar cisterns and is absent in the subarachnoid space. Patient gave a history of an arachnoiditis three years ago. For the last year and a half there have been even more frequent epileptic fits.

In case of the presence of a far-reaching adhesive process and separation of the fluid in the subarachnoid spaces, it is possible to find in an open form the development of faint digital impressions in that region.

Closed Hydrocephalus (Fig. 5). The occlusion of the passageway, while separating the ventricles from the subarachnoid space,

FIG. 5. A., male, aged thirteen. The bones of the skull have become thinner. The line of the oval of the vault is even. The sutures are gaping. The venous furrows are developed (see frontal region). Digital impressions are sharply marked. In the sella turcica, the floor has become deeper mainly in the posterior lower part, its outlines are even; the back dorsum is shortened with greatly thinned posterior clinoid processes inclined towards the front. Owing to this the entrance of the sella is only relatively wide. Conclusion: Closed hydrocephalus extending back several years. Occlusion in the back cranial fossa in the region of the foramina of Magendie and Luschka. Confirmed by the autopsy.

leads to a decrease of fluid in the latter. In these conditions a higher intracranial pressure causes the appearance of the cardinal sign of occlusion in the roentgenogram—digital impressions. The time of their appearance and the degree of their development, as well as other roentgen signs, depend on the age of the patient, the period when the occlusion began, the duration of the process, the rapidity and intensity of its growth. The same causes of higher intracranial pressure, when there is a decrease in the subarachnoid layer of fluid and a weakening of its influence towards levelling the pressure, lead to the "compression" of the brain cortex to the bones, and therefore—when there is an occlusion—to a more complicated relief of the inner surface of the bone—to the development of deeper furrows of venous sinuses and the imprints of meningeal arteries and veins and consecutively to the development of diploic veins. The rapid growth of the intracranial pressure leads to a rapid distention of sutures, whose openings—provided the hydrocephalus has set in during the first years of life or before youth—are gaping widely and represented on the roentgenogram by a clearly defined dense streak; as to the dentation it is often less elongated than when there is an open hydrocephalus. The other reoentgen signs of closed and open hydrocephalus are similar and have been mentioned in the general enumeration of diagnostic signs, with the exception of the sella turcica, whose form in closed hydrocephalus as distinct from the open one, undergoes great changes and we shall now consider these in connection with the localization of the occlusion process.

The pathomorphological changes in the tissues of the sella turcica and the changes of its form depend, first of all, on and can be explained by certain hydrodynamic conditions, and in this connection the effect on the sella will vary in accordance with the level of occlusion.

The causes of occlusion usually take place in the narrower parts of the passages, i.e. (1) near the foramen of Monro; (2) in the aqueduct of Sylvius; (3) in the region of the fourth ventricle and near the foramina of Magendie and Luschka. For the time being, we shall not consider the conditions attending the occlusion near the foramen of Monro.

The Sella Turcica in the Occlusion of the Aqueduct of Sylvius. In an occlusion at the level of the aqueduct of Sylvius in many cases, depending on the cause (neoplasm, inflammatory changes), there occur edema of the brain tissue and membranes, a hampered return flow and later apart from the closing of the aqueduct of Sylvius, the "compression" of the tentorial opening itself and the resulting separation between the hollow for the big brain from the hollow for the small brain. When difficulties begin in the return flow through the vena cerebri magna, the production into the lateral and third ventricles will be increased thanks to

the transudation from the veins. The difference in pressure between the big cavity and the posterior cranial fossa will grow in favor of the upper. Under such conditions the intracranial pressure exercises its influence simultaneously on two horizontally situated plates, which conditionally hermetically divide the hollows—the diaphragm of the sella turcica *D* and the tentorium cerebelli *T* trying to bend them downwards (Figs. 6 and 7*a*).

Such downward bend of the tentorium in similar cases has been noted and confirmed by Burdenko and Swift. Since the diameter of the tentorium is larger than the diameter of the diaphragm of the sella turcica, the force applied to the first (*T*) is larger than the force applied to the second (*D*), in proportion to their sizes. Point *Ca* representing anterior clinoid processes and point *I* (inion), the occipital bone, are immovable; then the hydrodynamic efforts, taken and transmitted by the strained membranes will most of all affect the weaker point *Cp*, the posterior clinoid processes, and will lead to the deviation of the latter and of the dorsum sellae posteriorly. With the further distention of the diaphragm of the sella turcica and the penetration of the extended infundibulum of the third ventricle into the pituitary fossa the distention of the entrance to the sella will be increased, the floor relatively even, smooth and round will be deepened. The anterior aspect of the dorsum sellae and the anterior parts of the posterior clinoid processes, experiencing the pressure more strongly than its posterior aspect, open to the posterior cranial fossa, where the pressure is much lower, will undergo more obvious atrophy than the posterior aspect. The height of the dorsum experiences fewer changes than at the occlusion in the posterior cranial fossa. Such character of the sella turcica is shown in the case of closed hydrocephalus, from a neoplasm of the trunk part in the region of the quadrigeminal bodies (Fig. 8).

A similar picture of the sella turcica in the case of a man, aged twenty-two (Fig. 9), in spite of the small changes in the cranial vault, enabled us to suppose on ground of the roentgen picture the presence

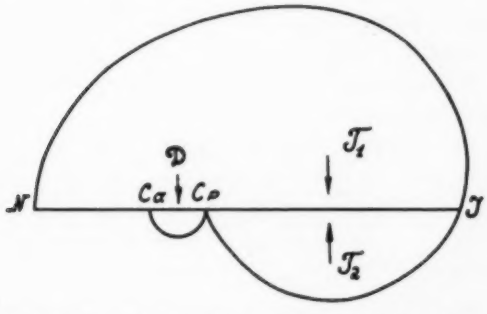

Fig. 6. Schematic drawing of effects of hydrodynamic forces on the dorsum sellae in closed hydrocephalus showing the tentorium cerebelli and the diaphragm of the sella.

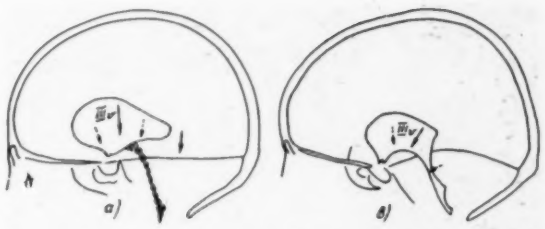

Fig. 7. Schematic drawing of effects of hydrodynamic forces in closed hydrocephalus on the dorsum sellae through the cerebral tissue: (*a*) when there is an occlusion in the aqueduct of Sylvius, (*b*) when there is an occlusion in the foramina of Magendie and Luschka.

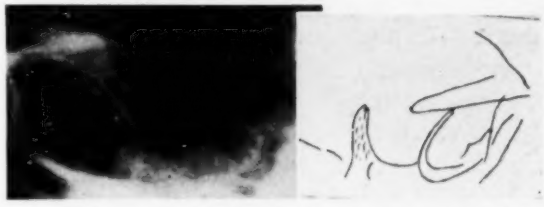

Fig. 8. I., male, aged eleven. In the vault, in the roentgenograms of the entire skull (not shown in print) there are typical signs of occlusional hydrocephalus (the form of the vault, the thickness of the bones, the distended gaping sutures, impressiones digitatae). The basal angle is not increased. The sella turcica in the cut shown above has a deepened floor (*especially in the part free from pneumatization*), a relatively wide entrance to the pituitary fossa with a dorsum rather straightened than bent forward. There is no atrophy of the posterior clinoid processes nor is there any shortening of the dorsum; on the whole the dorsum is porous. Closed hydrocephalus with occlusion at the level of the tentorial opening. Autopsy: neoplasm in the region of the aqueduct of Sylvius.

FIG. 9. Y., male, aged twenty-two. No convincing signs in the cranial vault. The anterior clinoid processes are neither raised nor lowered. In the sella turcica, the floor is evenly rounded and moderately deepened, its outlines are smooth, the dorsum sellae is straightened and is rather inclined posteriorly. The posterior clinoid processes in their frontal part are not seen. Roentgenological conclusion: the changes of the sella turcica are of secondary hydrocephalic nature. The conditions of occlusion are apparently at the level of the aqueduct of Sylvius. Autopsy: neoplasm of the quadrigeminal bodies.

of a closed hydrocephalus with an occlusion of the aqueduct of Sylvius and with a compression of the tentorial opening. Neurologically Prof. V. V. Kramer established the diagnosis of tumor of the quadrigeminal bodies.* An operation by Dr. N. N. Burdenko has confirmed this diagnosis.

In a similar case occurring in a man, aged thirty-five, in which on the ground of the tendency of the dorsum to lean backward, the atrophy of the anterior aspect of the dorsum, the even deepening of the floor and a suspicion of beginning digital impressions in the frontal part of the cranium, we made the diagnosis of a closed hydrocephalus with an occlusion on the level of the tentorium; the post-mortem examination revealed the closing of the aqueduct of Sylvius, owing to the adhesive ependymitis.

The Sella Turcica in Occlusion in the Posterior Cranial Fossa. The occlusion below the aqueduct of Sylvius in the region of the fourth ventricle of the foramina of Magendie and Luschka leads, in cases of hydrocephalus, to the distention not only of the lateral and third ventricles, but also of the aqueduct of Sylvius itself. There are no particular conditions for a complete closure of the tentorium opening during the first periods of affection. The intracranial pressure is raised but it is equal both below and above the tentorium, and the forces which press on it from above (T_1) and from below (T_2) are balanced and neutralize each other. Thus, point *Cp* (the posterior clinoid processes, Fig. 6) in this case experiences only the traction from the diaphragm of the sella turcica transmitting the force of pressure from above (*D*), and since the point *Ca* (the anterior clinoid processes) is immovable, the point *Cp* (the posterior clinoid processes) are drawn to the diaphragm, i.e., forward, and at the same time the dorsum sellae assumes the tendency to lean forward.

Another important factor, determining the configuration and direction of the dorsum at this level of occlusion, i.e., in the fourth ventricle of the foramina of Magendie and Luschka, as distinguished from the occlusion in the aqueduct of Sylvius, is the circumstance that the dorsum sellae is in the present case, so to say, enveloped by the bent channel of the fluid mainly from behind, from above and only partially from the front. This channel is formed of the aqueduct of Sylvius and the third ventricle with its infundibulum. The raised pressure of this channel does not encounter an equal resistance on the part of the fluid of the basilar cistern, separated by the occlusion from the ventricles and consequently lacking an afflux of fluid. The pressure in the cisterns must be lower than the pressure in the four ventricles. Thus the higher pressure in the bent channel formed of the third ventricle and the aqueduct of Sylvius is

* The plane of the tentorial opening passes through the anterior colliculi of the quadrigeminal bodies and the pedunc'es of the cerebrum near the outlet of the third pair of nerves.

transmitted through the tuber cinereum to the dorsum sellae mainly from above and from behind (Fig. 7*b*). Its osseous tissue becomes atrophied from pressure, the dorsum becomes thinner, shorter and creased or sometimes infractured, according to its most frequent form and to the undermined state of its anterior aspect, naturally in the forward direction where, moreover, the diaphragm of the sella turcica draws its posterior clinoid processes. The entrance of the sella turcica when there is an occlusion in the posterior cranial fossa has therefore no special tendency to increase, but rather narrows and if it widens at all in certain cases, does so only to a relatively small extent (see Figs. 5, 10, 11 and 12). It is somewhat more difficult to explain the form of the floor of the sella turcica which in most cases deepens chiefly in its posterior part, which Stenvers determines as the growing separation between the parallel lines of the floor of the sella and of the floor of the sinus of the basal bone.

Fig. 10. T., male, aged twenty-two. The sella turcica is typical of an occlusion in the posterior cranial fossa. The medial part of the floor of the sella is bent down into the lumen of the basilar sinus. The dorsum is greatly atrophied. The scarcely perceptible posterior clinoid processes are directed towards the front. The anterior clinoid processes are atrophied. The vault of the skull does not reveal any special signs. Operation: neoplasm of the vermis. Autopsy.

This condition undoubtedly often takes place in an occlusion of the posterior cranial fossa—it is more convenient to define it as the parting of the lines of the floor of the sella and of the medial cranial fossa to be intersected behind. We believe that this depends on a number of circumstances and

Fig. 11. P., female, aged sixteen. In the sella turcica the medial part of the floor is smoothly outlined and somewhat lowered into the lumen of the basilar sinus. The dorsum is atrophied and straightened. The posterior clinoid processes preserve their direction. The entrance to the saddle is relatively wide. There are no changes in the vault. The changes of the sella are of a secondary nature. Occlusional conditions in the back cranial fossa. The history reveals that three years ago there was an inflammatory affection complicated by osteitis. Operation (Prof. N. N. Burdenko): decompression in the back cranial fossa. There was disappearance of the papilladema, restoration of sight and equilibrium and cessation of hydrocephalitic phenomena.

is best explained by the posterior part of the floor of the sella becoming first of all yielding, the floor at that place usually consisting of a spongy tissue, easily atrophied under the influence of the pressure exercised on it by the dorsum, which in its turn is experiencing the pressure of the third ventricle and the widened aqueduct of Syl-

Fig. 12. Ts., male, aged thirty-three. (In the Botkin Hospital.) The cranial vault was without special changes (not shown). The sella turcica shows the medial part of the floor bent down into the lumen of the sinus in its lower and backward part. The dorsum sellae is thinned and bent is such a way that the posterior clinoid processes are inclined towards the front. The entrance to the sella is relatively not wide. Conclusion: the changes in the sella are of secondary hydrocephalic nature. Closed hydrocephalus. Occlusion in the posterior cranial fossa at its lower end. The corresponding clinical signs appeared after six months. Autopsy after a year and a half: tumor of the vermis.

FIG. 13. P., female, aged twelve. In the anamnesis, one and a half years ago, meningo-encephalitis. Roentgenography shows gaping coronary suture. Traces of digital impressions in the frontal region. Sella turcica with the dorsum bent (infractured) towards the front. The last sign categorically establishes occlusional hydrocephalus with closing of the paths of communication in the fourth ventricle. Ventriculography and color test confirm hydrocephalus and the impassability of the paths of communication, without establishing the level of the obstruction.

vius. The anterior part of the floor of the sella turcica resists longer to the lowering process, because precisely under that part is most often situated the sinus of the basal bone. The air pressure in the basilar sinus which is equal to the atmospheric pressure and exceeds it at the moment of expiration along with the vaulty nature of the root of the sinus, is a solid construction capable of standing a considerable pressure. In cases of such a location of the sinus of the basal bone the air cavity along with the vaulty construction of the roof offers a constant resistance to the tendencies of lowering the floor of the sella, which consists here of a resilient osseous plate of a cortical structure (see Fig. 8).

A relatively small difference in the amount of pressure which the vault of the basal sinus resists even for a long period of time will be intelligible to us, if we take into consideration the air pressure in the sinuses equal to the atmospheric 10,330 mm. of the column of water and somewhat higher and in the ventricles of the brain in a closed hydrocephalus, on an average 10,500–10,800 mm.

When there is a greatly pneumatized body of the basal bone, the lowering of the floor of the saddle is sometimes not marked at all or is expressed weaker, and in case pneumatization spreads underneath the back part of the floor, there may be no marked deepening of this part, there will remain only a strong atrophy of the dorsum and usually its shortening.

According to the form of the brain and the ventricles, the form and architecture of the sella itself and of its dorsum and to the nature of pneumatization of the body of the basal bone, there arise conditions for great deviations and a variety of forms of changes both of the floor and of the dorsum in closed hydrocephalus. The sella turcica, in the shape of a box with osseous bridges between the posterior and the middle clinoid processes, may possibly not show typical changes even when occlusional hydrocephalus has progressed considerably, when there are strongly marked digital impressions, imprints of vessels, gaping sutures, etc. A massive dorsum also resists the changes for a considerably longer period than one which is fairly high, thin and slender.

The dorsum of the latter type when there is a lower occlusion in the posterior cranial fossa, i.e., near the foramina of Magendie and Luschka may before all other signs give an infraction of the dorsum with a forward bending of its upper part (Fig. 13). Such changes in the dorsum as the first and important sign may be met when there is an occlusion of the foramina of Magendie and Luschka after basilar leptomeningitis or when there is difficulty in the return flow of the fluid through them in cases of the lowering of the oblong brain in the occipital hole and the compression of these holes when there is a neoplasm of the cerebellum, of the fourth ventricle or of the cortex, compressing this ventricle.

In cases of larger or higher situated neoplasms, when there can set in conditions of

compression in the aqueduct of Sylvius and in the tentorial opening, the interrelation of hydrodynamic forces changes, the dorsum will experience a traction in the backward direction and with no bending forward. It may, on the contrary, display a tendency to widen the entrance to the pituitary fossa with a straightening of the dorsum and even with a certain deviation in the backward direction. In such cases the deepening of the floor of the sella will also proceed after the type of high occlusion, according to the situation and nature of the occlusional conditions; the deepening of the backward part of the floor may possibly not take place, the floor will deepen evenly or there may arise even a tendency toward deepening in its anterior part.

Finally, it is necessary to indicate that in rare instances of a large neoplasm in the frontal lobe of old origin, a typical roentgenogram can be obtained, in which both the form of the sella turcica and the development of digital impressions indicate the presence of occlusional hydrocephalus with a compression at the level of the tentorial opening or at the floor of the posterior cranial fossa.

This is explained by the pushing of the whole brain in the backward and downward direction and the development in this way of occlusional conditions owing to the compression in the tentorial opening or in the occipital hole when the oblong brain descends into it.

In these cases the clinical signs may be scanty and atypical and there may be symptoms both of the anterior and of the posterior cranial fossa. The wrong interpretation of the roentgen picture may lead to an erroneous diagnosis and a futile operation in the posterior cranial fossa. In a similar case (see Fig. 14) of a large meningioma in the frontal region of a man, aged twenty-three, a correct diagnosis was made by us only because of the presence of hyperostosis in the small wing, and had there been no such sign, we would undoubtedly have made a diagnosis of only an occlusion in the posterior cranial fossa or rather at the level of the tentorial opening, and we would not have suspected a neoplasm in the anterior fossa.

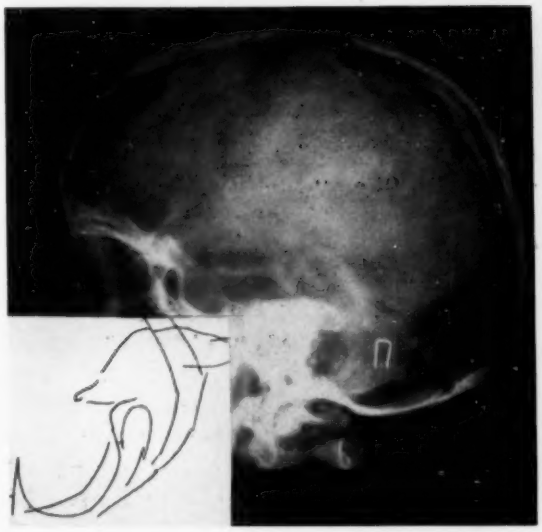

Fig. 14. Male, aged twenty-three. Sharply pronounced changes in the cranial vault and the sella turcica indicate occlusional conditions, possibly at the level of the tentorial opening. The hyperostosis on the little wing establishes the presence of meningioma in the anterior cranial fossa. The meningioma has been removed (Prof. N. N. Burdenko) with an excellent result. The presence of well-developed digital impressions and the changes in the sella are explained by the many years old hypertension conditions and difficulties in the return flow, owing to the pushing of the brain in a backward direction and the compression near the tentorial opening.

In analyzing the lateral roentgenogram of the sella turcica one must bear in mind that sometimes its form in the occlusion of the posterior cranial fossa is similar to that of a neoplasm deep in the temporal lobe. In both cases we can have an egg-shaped pituitary fossa extended in the backward direction. But whereas in the former instance the atrophy of the posterior clinoid processes and shortened dorsum are typical, in the latter case we can have a slender, rather elongated dorsum. Apart from this the underminedness from below of one of the anterior clinoid processes, which is encountered in the neoplasms in the temporal region convinces us of the correctness of the differential diagnosis.

Both the roentgen diagnosis of hydrocephalus and the establishment of its form and, furthermore, in cases of closed hydrocephalus, the hypothesis concerning the location of the occlusion can only be made as a result of a correlation of all the roentgen signs, both of the entire skull and of one of its parts—the sella turcica.

From this point of view the dialectical method of reasoning applied by Dr. G. V. Stenwers to the question of the changes in the cranium and in the sella turcica in hydrocephalus seems to us correct and useful. We refer to the method of reasoning, such as we understand it, concerning the value of isolated and separate signs such as for example, the sign "of the parting of parallel lines of the floor of the sella and of the basilar sinus," a sign which is inconstant and which we never understood to be the only one and the one determining all relations.

The various roentgen appearances of the sella turcica and the difficulty of a differential diagnosis of primary and secondary hydrocephalic changes in it in certain cases in adults are authoritatively demonstrated in the fundamental work of Mayer[5] and are not discussed here, yet we are of the opinion that the difficulties in this connection are encountered considerably less often and in disputed cases the above propositions have made a correct analysis of the roentgenogram easier.

It is also necessary to take into account the secondary changes in the sella turcica when there are large neoplasms in various parts of the cerebrum, which by their mass action cause conditions of hypertension and thus lead to deformations of the sella turcica, which are difficult to interpret. Yet even in such cases, as regards the smoothness of its floor, the bending of its middle part, the atrophy and shortening of the dorsum and sharpening and flattening of the anterior clinoid processes, the roentgenologist can give an opinion against the local destruction of the sella and say that its changes are due to a secondary effect.

Finally, the combination of the primary destruction of the sella turcica and the secondary hydrocephalic phenomena may cause considerable difficulty in roentgen diagnosis.

None the less there remain rare instances when among adults, in the absence of signs in the vault, the changes in the sella and the neighboring regions are so devoid of typical features that on the basis of roentgenographic data we have no grounds for deciding in favor of any of the groups of the local destruction of the sella, nor for establishing whether the changes in the sella are in this case primary or secondary.

We resort to the contrast methods, as a rule, only for purposes of checking and of obtaining supplementary data. In view of the fact that there is a possibility of an occlusion with the presence of a neoplasm in the posterior cranial fossa, we avoid the lumbar method and apply ventriculography after a preliminary color test. The uranine test gives us some idea whether the ways may be open or closed, and together with ventriculography completes the question of hydrocephalus of the ventricles. We say "completes," because none of the methods at our disposal supplies an immediate and exhaustive reply concerning the presence of hydrocephalus, its form, the localization of occlusion, the degree of its development, and none is absolutely exact and convincing in all cases, and it is a question in our opinion which of the methods, of roentgenography, the lumbar puncture, the color test and ventriculography and encephalography gives, on an average, a larger percentage of correct and conclusive replies. We give preference to roentgenography.

Having established the diagnosis of closed hydrocephalus, we must deal with the important question whether occlusion is caused by inflammatory changes and their consequences, or by a neoplasm. We cannot reply to this question merely on the basis of roentgen investigation unless there are primary signs or a deformation of the ventricles.

On the other hand, the roentgen picture

in hydrocephalus is the only method preserving the anamnestic data for several years, which cannot be obtained either by a most thorough clinical history, or by other methods before operation or autopsy. Thus, in accordance with the changes in the configuration of the cranium and of its base, with the lowering of the sella turcica, the increase of the basal angle, the extension of the cranial fossae, the state of the sutures and their hiatus, the degree of development of the digital impressions, the roentgenologist can judge of the duration of the process. This is particularly important in a group of neoplasms which occur in children without clinical signs for many years—angioblastoma and ependymoma in the fourth ventricle or the astrocytoma, growing in the fourth ventricle (Cushing). In these cases the roentgen signs of an old closed hydrocephalus, when there is a clinical picture of a relatively recent manifestation and the typical course of the disease, indicates not only the presence of a neoplasm and of its possible localization, but gives some indication of its anatomic nature.

Finally, there can be cases when lumbar puncture, encephalography and the color test show the presence of open hydrocephalus and only the roentgenogram (Fig. 15) with developed digital impressions and the sella turcica typical of the closed lower hydrocephalus serves as the only evidence of a closed hydrocephalus which existed for a long time, and which has passed into an open form, which is proved by other methods of investigation. In similar cases a roentgenogram can give an idea of the intermittent type of hydrocephalus with temporary closing or compression of the paths of communication.

In some cases in the adult of hydrocephalus of long standing, we can surmise from the thickened borders of the preserved sutures the existence of periods of stabilization in the development of hydrocephalus, during which the reactive induration of the osseous tissue has taken place.

In order to test the value of roentgenographic signs, 50 cases were selected from among our material on hydrocephalus. These were established by detailed neurological and instrumental investigation.

Fig. 15. Male, aged twelve. Clinical examination and puncture with color test establish an open form of hydrocephalus. Roentgenography supplements the history and indicates that hydrocephalus has been developing for a long time after the type of closed hydrocephalus in the lower part of the back cranial fossa. Note the configuration of the sella turcica, the relief of cranial bones.

The correct differential diagnosis between closed and open hydrocephalus established by roentgenography is 90 per cent. This percentage in our cases is lowered to 80 per cent in cases in early childhood, and exceeds 90 per cent if we reject doubtful cases. We do not quote statistics according to separate signs, because we do not regard the number of the confirmed cases sufficient to draw statistical conclusions, the more so since even the technical roentgen possibilities and a number of other circumstances may largely modify these figures.

SUMMARY

1. The diagnosis of hydrocephalus can be established by means of roentgenograms with a considerable degree of probability in some cases and categorically in others.

2. Secondary signs in the cranial vault and in the sella turcica on a roentgenogram give, in an overwhelming majority of cases,

TABLE I

PRINCIPAL ROENTGENOGRAPHIC SIGNS IN HYDROCEPHALUS

	Sella Turcica	Digital Impressions	Vessel Furrows, Diploic Veins	Sutures	Configuration of the Skull and Fossae, the Thickness of the Bones	
Open hydrocephalus	Preserves its form in children. Only in adults at later stages becomes changed in a cup-like manner, the floor being deepened to a small degree and evenly, the entrance being widened, the dorsum being moderately shortened without a forward inclination. The anterior clinoid processes may be lowered	The relief of the bones is smoothed.		Are distended more often with elongated dentation in children	The child's skull is smooth and round of the shape of a sphere, or of an airship. The vault and the cranial fossae have a large radius. These signs are the less pronounced the later hydrocephalus sets in	Signs showing the period hydrocephalus set in. In juveniles: Severe changes in the configuration of the skull, a great basal angle, widely distended or gaping sutures. In adults: Apart from the changes in the sella turcica there is a more complicated relief of the skull bones
		Do not develop	Do not develop			
Closed hydrocephalus. Lower	Changes its form; the posterior clinoid processes display a tendency to a forward inclination; the dorsum is atrophied, shortened or bent forward (infractured). The entrance is widened to an insignificant degree. The floor is deepened chiefly in the back part	The relief of the bones is more complicated		Often with shortened dentation	The same as above—the changes of the general configuration of the vault rarely take place in adults and it is the changes in the sella turcica which are prevalent	
		Developed	Developed			
Upper	Changes its form; the posterior clinoid processes and the dorsum become straightened and display a tendency towards a backward inclination. The anterior aspect of the dorsum is atrophied. The height of the dorsum changes relatively little. The entrance is extended considerably more than in the lower occlusion. The floor is more evenly deepened	The same as above	The same as above	The same as above	The same as above in the vault, but the basal angle does not increase	

a ground for differentiating an open from a closed hydrocephalus.

3. In case of a closed hydrocephalus, it is in many instances possible to indicate according to the configuration of the sella turcica whether occlusion has taken place below the tentorium cerebelli in the region of the fourth ventricle or higher—in the region of the aqueduct of Sylvius at the level of the tentorial opening.

4. A diagnosis of fully developed closed hydrocephalus may be made with considerable accuracy by roentgenography alone, without the aid of contrast methods.

5. In open hydrocephalus, encephalography gives added information concerning the possibility of non-resorptive conditions in a given case.

6. Roentgenography of the skull in hydrocephalus may add to the ideas gained from a clinical history of the case.

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EARLY ROENTGEN DIAGNOSIS OF JEJUNAL LYMPHOSARCOMA

REPORT OF CASE

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THE early roentgen diagnosis of jejunal lymphosarcoma is unusual. In the literature, the concept "x-rays are valueless in the early diagnosis of lymphosarcoma of the small bowel," is almost unanimous. However, with due care and precision in detail, such a diagnosis can be arrived at, as was done in the case cited below.

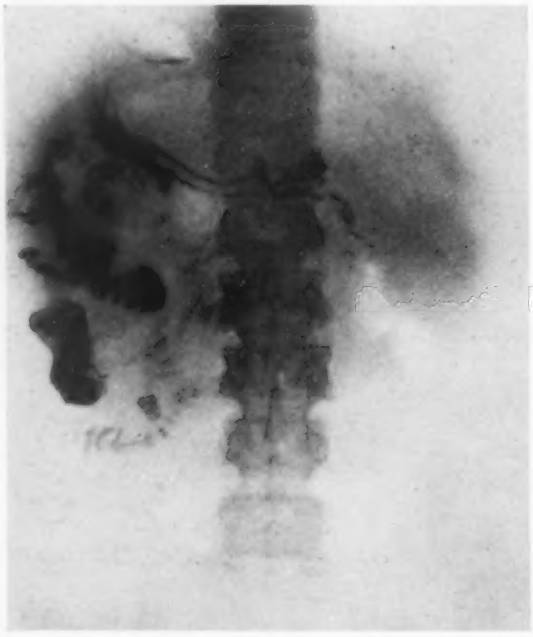

FIG. 1. Roentgenogram taken one hour after ingestion of barium, showing deformity of upper jejunal loop.

Technique. The technique largely suggested by Berg[2] was followed. The patient ingests small amounts of the usual barium mixture every fifteen minutes over a two hour period. Half hourly to hourly films are taken for a period of four hours, the time usually taken for the bulk of the meal to traverse the small gut and reach the cecal area.

The normal jejunal shadow occupies the left upper quadrant and is feathery in appearance, while the ileum occupies the right lower quadrant and is tube-like in structure, with some degree of haustration. Alteration in structure of the jejunal shadow reveals itself in the form of rigidity, fixation, sacculation or constriction of the loops, with some proximal dilatation.

Films taken at twenty-four and forty-eight hour intervals, as in the present case, may demonstrate stasis and retention of barium in the jejunal loops after the remaining loop has been completely evacuated.

FIG. 2. Roentgenogram taken four hours after ingestion of barium, showing jejunal deformity.

Incidence and Origin. The incidence of lymphosarcoma is more frequent in the

small, than in the large intestine, the ratio being 2:1. The most frequent site of occurrence in the gastrointestinal tract is in the ileum; the cecum, jejunum and rectum respectively follow in order of frequency. It is found in greatest numbers during the first, third and fourth decades of life, and predominates in the male.

The frequency of occurrence in the ileocecal region, rich in lymphoid tissue, and the incidence largely in the first decade, together with its location in the submucosa, suggest the possible embryonic origin of intestinal lymphosarcoma. Carcinoma of the appendix, having many features in common with this entity, similarly is thought to be embryonic in origin.

CASE REPORT

H. A. C., male, aged fifty-one, salesman. In April, 1934, the patient, previously in good health, suddenly developed diarrhea associated with abdominal cramps, which he attributed to dietary indiscretion. A bismuth mixture which was prescribed for him afforded no relief. Diarrhea persisted, the movements increased in number and the patient began to lose weight. He was referred for a barium enema study of the colon to rule out carcinoma of the colon. This was negative. The patient gradually lost more weight and strength. The upper gastrointestinal tract was then studied; a lesion of the stomach and first portion of the duodenum was ruled out. Following the technique outlined above, the small gut was studied, and revealed a constant deformity of an upper jejunal loop, which was found on all films, including the twenty-four hour study. It was characterized by infiltration of the walls of that loop, rigidity, fixation, a localized constriction with sacculation of the proximal loops.

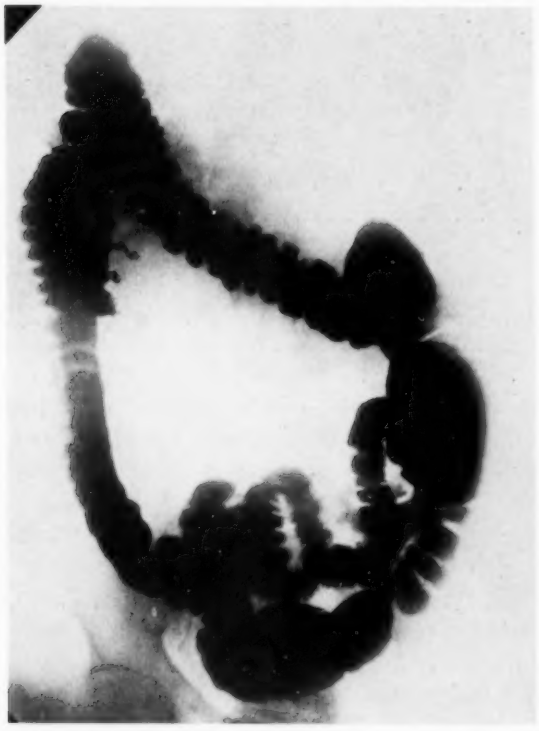

Fig. 3. Roentgenogram taken after barium enema. Anteroposterior view showing overlapping of deformed jejunal loop and colon.

Fig. 4. Roentgenogram taken after barium enema. Oblique view showing relation of colon to deformed jejunal loop.

A barium enema was repeated to exclude a fistulous tract between the affected jejunum and colon. The affected jejunal segment was found overlying the sigmoid and in the oblique view was noted as entirely separate from it.

From the roentgenograms, a diagnosis of an infiltrating lesion of the jejunum, probably lymphosarcoma, was ventured and the patient

was admitted to the Jewish Hospital of Brooklyn.

Operative Findings. Under spinal anesthesia, an upper left rectus incision was made, and a tumor-bearing segment of jejunum was delivered, which was proximal to the ligament of Treitz. The mass was resected and an end to end anastomosis by means of a Murphy button was done; closure was effected in the usual way.

Pathological Findings.

Macroscopic. The specimen was 29.5 cm. long; about 15 cm. of the midportion was occupied by a new growth producing a thickened wall, the maximum thickening measuring 1.5 cm. The mucosa throughout this 15 cm. was very much thickened, firm, with a tendency to papillary formations projecting into the lumen of the gut. One portion of the segment, separate from the main mass, formed a band 3 cm. in width encircling the lumen. The serous coat was fairly smooth and not involved except for a small area 0.5 cm. in diameter of red discoloration. This was opposite a small ulceration of the mucosa of the mass similar in size.

Microscopic. Sections through the mass showed it to be composed chiefly of small round cells of fairly uniform size which presented evidences of malignancy, including mitotic figures. These cells occupied to a small extent the mucosa, being found mainly in the submucosa and including the muscularis. The serosa was not affected. The lymph node structure appeared uninvolved. A part of the mucosa was the seat of an inflammatory and necrotic process.

Progress. After an uneventful postoperative course, the patient was discharged from the hospital in fourteen days. Deep roentgen therapy was instituted and completed in June, 1934. Recovery was remarkable, the patient reaching his normal weight and assuming his usual activities within three months. In January and July, 1935, the patient received additional deep roentgen therapy, and up to the present his condition is excellent.

Fig. 5. Photomicrograph of section. Small round cell lymphosarcoma. Low power.

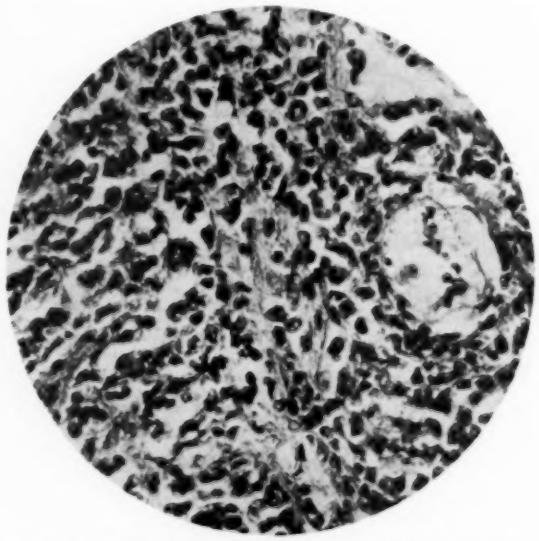

Fig. 6. Photomicrograph of section. High power.

Comment. Because of the absence of fibroblastic elements, lymphosarcoma of the intestines usually does not constrict the gut. On the contrary, the tendency is to cause sacculation. Assmann[1] describes similar findings in his cases. He states that lymphosarcoma does not produce stenosis, but does produce stiffness of the walls of the intestine, together with ulceration which may later result in sacculation. Roentgenologically the involved small bowel presents itself as smoothed loops. The valvulae conniventes are absent and the loops may remain filled for a variable period after the remainder of the bowel has emptied. This stasis is due to the rigidity and fixation of the loops through infiltration of its walls by new growths.

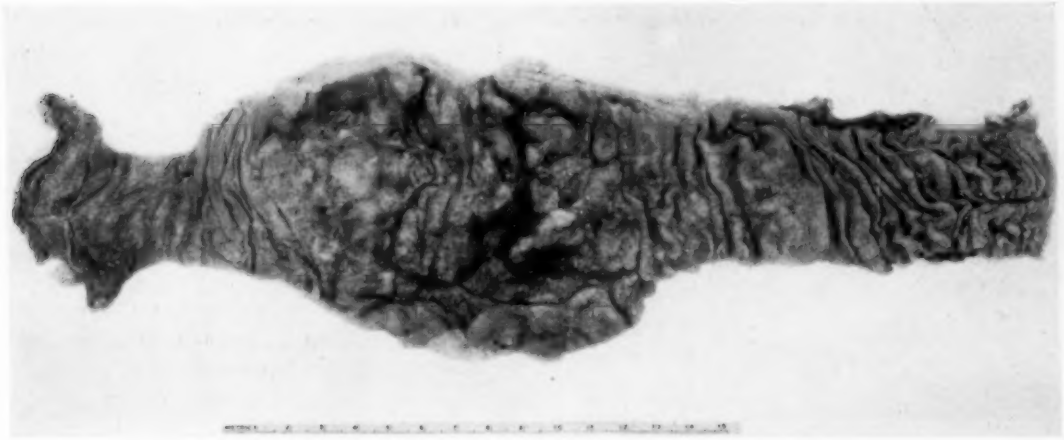

Fig. 7. Gross specimen showing new growth of jejunum.

Roentgen diagnosis of intestinal tumors usually depends on deformity in outline of the shadows, and by signs of obstruction through constriction, encroachment on the lumen or by intussusception. In Hodgkin's disease and leukemia affecting the bowel, obstruction may or may not occur. This usually depends on the degree of fibroblastic elements present. In carcinoma of the bowel, constriction with resultant stenosis is usually present, together with proximal dilatation.

The prognosis in localized lymphosarcoma of the small intestine after resection is hopeful (personal communication from Dr. Carl Weller, pathologist, University of Michigan). In this case, there were no demonstrable regional node involvements, as a result of which the patient was given favorable prognosis.

SUMMARY

A case of lymphosarcoma of the jejunum is presented with preoperative roentgen findings, and confirmatory operative and pathological findings.

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GASTROJEJUNO-COLIC FISTULA*

CASE REPORT

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IN SEVERAL recent articles, the subject of gastrocolic and gastrojejuno-colic fistula has been admirably discussed. As pointed out, this lesion is seen as a result of carcinomatous degeneration or as a sequence to a gastrojejunostomy for pyloric or duodenal ulcer.

We believe this case to be somewhat unusual in that the fistulous tract developed between the gastrojejunal opening of a previous gastroenterostomy and the colon near its splenic flexure complicated by a blind duodenal loop as a result of a closure of the pylorus, and a clear demonstration of the entire pathologic process by roentgen examination.

REPORT OF CASE

J. L. M., aged forty-eight, a city employee in the Bureau of Water, first came under the private medical care of one of us (M. S. J.) in April, 1926, complaining of peri-umbilical pain, gaseous distention and dyschezia.

In developing his medical history it was found that an appendectomy had been performed in 1912 for an acute attack, and that in 1916 he had had a duodenal ulcer operated on by Dr. John B. Deaver. The hospital record showed that the ulcer was excised, the pylorus was closed off and a gastroenterostomy performed.

From April, 1926, for a period of eight years, he was in comparatively good health with only an occasional attack of epigastric pain, diarrhea or vomiting. These were thought to be manifestations of marginal ulcer, but since the attacks were never severe, the patient refused complete study.

On March 28, 1934, after a lapse of five years without any medical care, he returned with the following symptomatology: diarrhea of several weeks' duration, associated with marked "rumbling in the intestines." The stools were ribbony and frothy. He had had nausea and occasional vomiting. He had lost some 10 pounds in weight, felt weak and dizzy.

After several weeks of treatment, he failed to improve, and was admitted to the Jewish Hospital, May 18, 1934, on the medical service of Dr. J. C. Doane.

Examination at that time revealed moderate emaciation, early arteriosclerosis, and a somewhat "doughy" abdomen. There were no masses palpable and no areas of tenderness.

Gastric analysis performed the day after admission gave a normal curve except that the contents had a fecal odor. All other laboratory tests were within normal limits but the urine revealed evidence of a chronic nephritis.

A complete roentgen examination of the gastrointestinal tract was made. The lesion was best demonstrated by the opaque enema, the report of which was as follows: "The opaque solution fills the entire colonic tract, but simultaneously also fills the stomach through a fistulous tract in the region of the gastrojejunostomy. After partial evacuation, we believe we can see a definite fistulous tract connecting the gastrojejunostomy with the splenic flexure."

An hourly study of the stomach by the oral administration of the barium mixture demonstrated the opaque mixture escaping through the gastrojejunostomy opening into the jejunum and simultaneously into the descending colon and sigmoid. A film taken one and three-quarter hours following the administration of the barium meal shows the entire small intestine empty, the stomach retaining about 50 per cent of the original meal, and the remainder throughout the distal colon. A film taken one hour later definitely shows a fistulous tract between the greater curvature of the stomach and colon about 2 inches proximal to the splenic flexure. Roentgen diagnosis: Gastrojejuno-colic fistula.

On June 1, 1934, he was transferred to the surgical service of Dr. Moses Behrend with the diagnosis of gastrojejuno-colic fistula. Operation was performed by Dr. Behrend on June 2, under spinal anesthesia, which we summarize:

On opening the abdomen the following was seen: There had been a pylorectomy for the

* From the Radiological and Medical Services of the Jewish Hospital, Philadelphia.

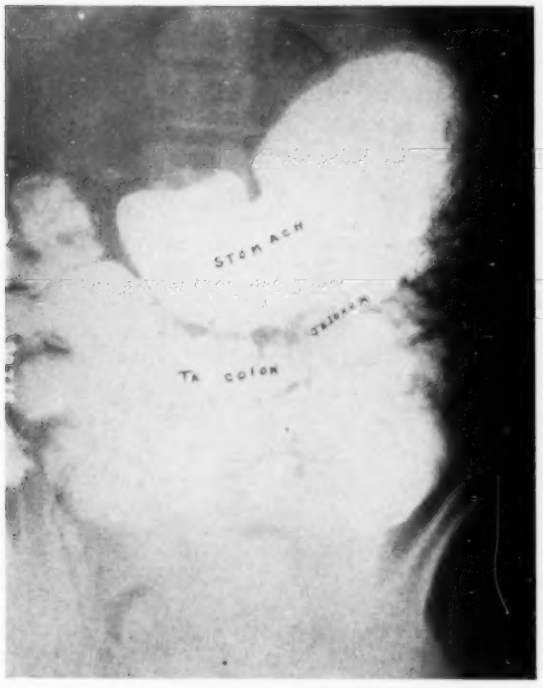

Fig. 1. Gastrojejunostomy twenty-three years ago, with pyelorectomy. Stomach fills by contrast enema.

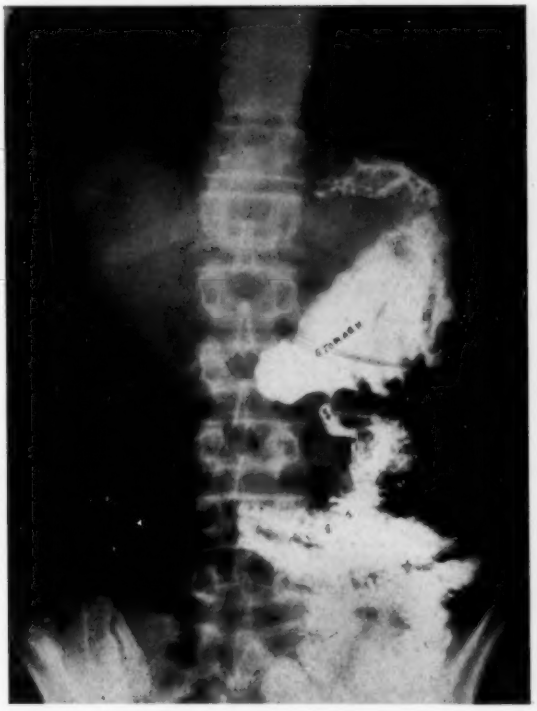

Fig. 3. Postoperative film, demonstrating the new gastroenterostomy opening and the new jejuno-jejunostomy opening.

Fig. 2. Gastrojejunostomy and jejunocolic fistula, demonstrated by stomach filling.

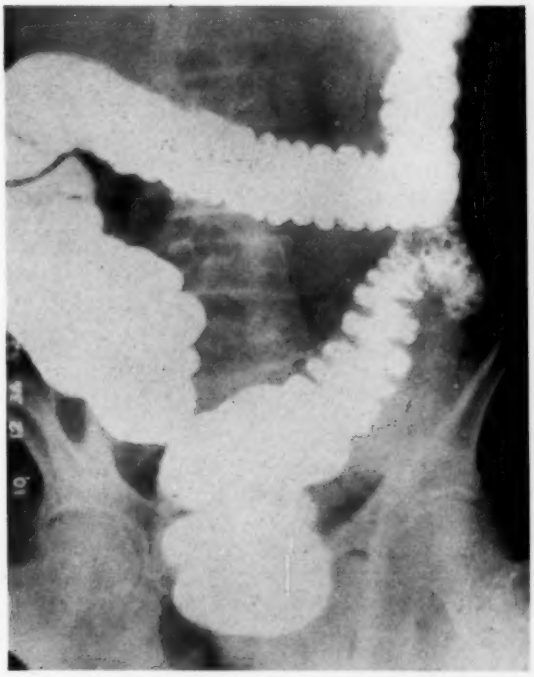

Fig. 4. Postoperative film. Colonic tract normal. Fistula closed.

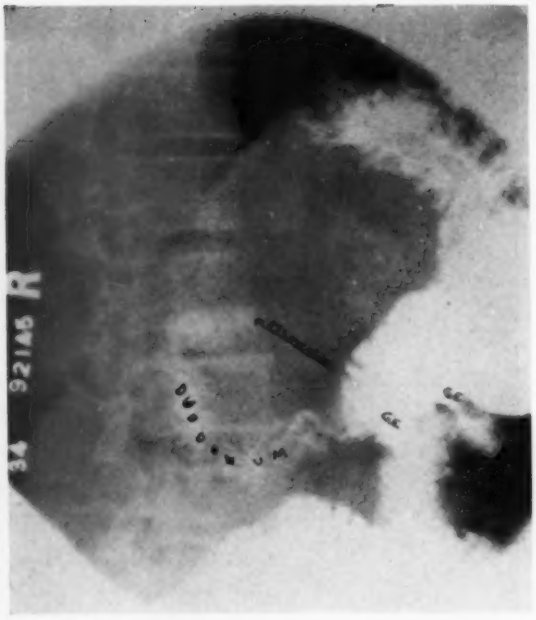

FIG. 5. Postoperative film, demonstrating the old and new gastroenterostomy opening, the area of pyelorectomy and blind loop of the duodenum.

cure of the ulcer. A well functioning gastrojejunostomy opening was found and an opening from the jejunum just proximal to the operative gastrojejunostomy was seen which communicated with the transverse colon near the splenic flexure.

The loops of gut participating in the jejunocolic fistula were separated and repaired. Another new gastrojejunostomy opening was made distal to the old one and to drain the blind loop of the duodenum resulting from the old pylorectomy, a jejunojejunostomy was done

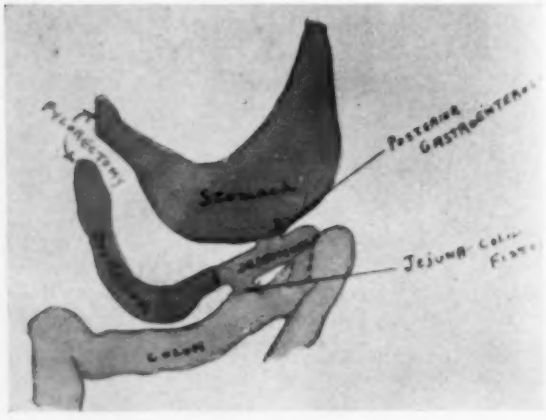

FIG. 6. Diagram of condition found at operation.

which shunted the contents of the loop whenever present into the jejunum instead of back into the stomach.

The condition found on operation and the procedures used in effecting repair are best seen in the accompanying illustrations (Figs. 1, 2, 3, 4, 5, 6 and 7).

Five days postoperatively he developed a cough with signs suggesting acute atelectasis. This, however, was not borne out by roentgen examination of the chest and in several days cleared up. On June 15, he suddenly began to vomit, which was temporarily relieved. On June 17, at 9 P.M., acute hematemesis set in,

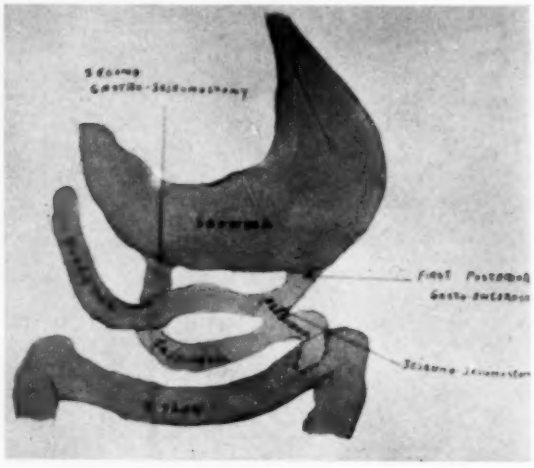

FIG. 7. Diagram of operative procedure. Compare with roentgenogram (Fig. 5).

associated with fecal incontinence. He rapidly went into shock, with dilated pupils, and air hunger. By midnight he seemed moribund. At 1:30 A.M. a transfusion of 350 c.c. citrated blood was given, after which he slowly rallied.

Several days later he again vomited and had excruciating lower abdominal pain. Two weeks later, on July 7, 1934, he again had hematemesis and signs of acute shock with rapid running pulse. Hypodermoclysis and transfusion were again performed, and repeated the following day. Following his second hemorrhage the blood count was: hb, 29 per cent; red blood cells, 1.5 million. Following his third transfusion he had no further complications and on July 24, he was discharged, fifty days after his operation. His weight at that time was 112 pounds. His blood count: hb, 50 per cent; red blood count, 2.7 million; white blood count, 12,000; differential count, normal.

He was placed on a bland, easily digestible diet with milk, eggs, fruit, and puréed vegetables as the main ingredients. Shortly thereafter liver was added and other meats. He was given iron hypodermically and at the present time (one year after his hospital discharge), he has been discharged from observation, weighing 170 pounds, the most in his whole life, with a normal blood picture. He is strong and able to work and feels better than ever before.

Comment. There are several very interesting features in this case. One that was not mentioned at all before was that the patient gave a history of having had lues twenty-five years before of which he was "cured." His blood Wassermann and spinal fluid were negative and gold sol negative. There had been a suspicion that the pains were those of tabes.

Another interesting feature was the length of time that the fistula took in its development to the point where the symptoms were sufficiently annoying to seek medical care.

Frequently in cases where there is a shunt in the digestion from stomach directly to the colon, severe grades of anemia develop and other signs of faulty metabolism. These were conspicuous by their absence.

The history during the patient's early stay in the hospital was suggestive of the shunt on account of the "taste" of the enema as it was given. This, of course, was confirmed by the roentgen examination and the exact location outlined.

His postoperative course was unusually stormy and at least on two occasions was at the point where his minister and family were summoned as his life seemed to ebb. However, he responded to stimuli and today he is a well man, thanks to the close cooperation of internist, roentgenologist and surgeon.

We acknowledge with thanks the privileges extended by Dr. Joseph C. Doane, Chief, Medical Service B, and Dr. Moses Behrend, Chief, Surgical Service, under whose supervision the patient was treated at the hospital.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-second Annual Meeting: Hotel Chelsea, Atlantic City, N. J., June 7–8, 1937.

EDITORIAL

CARCINOMA OF THE ESOPHAGUS

CANCER WEEK serves to emphasize anew the position of the roentgenologist not only in the cure of cancer but in its early diagnosis. The part that he has played in the cure of various forms of cancer is a well-established fact, but in spite of the advances that have been made in certain phases of the problem much remains to be done. One of the least encouraging chapters in therapy is the one dealing with carcinoma of the gastrointestinal tract, especially carcinoma of the esophagus and stomach. An analysis of any group of case histories collected by observers the world over brings out the fact that in spite of all our modern methods of diagnosis we have made little progress in the cure of carcinoma of the esophagus. What factors enter into this? Many. First, the inaccessibility of the esophagus and its intimate relation to other vital structures and its poor response to surgical trauma. The possibility of radical surgical treatment of esophageal neoplasm would appear to depend upon two debatable but related factors, namely, early diagnosis and virulence of the growth. In carcinoma of the esophagus the diagnosis is invariably late and this can be explained by the fact that the diagnosis is dependent upon the onset of symptoms, and unfortunately the early symptomatology is vague and its manifestations are apt to be regarded as trivial and unimportant. As McGibbon[1] has recently pointed out there is of necessity a latent period between the earliest carcinomatous formation and the patient's awareness of something amiss, and the duration of this period cannot be estimated. What is the most common complaint that causes the patient to seek advice? Difficulty in swallowing. Often a patient is sent to the roentgenologist with this vague sort of complaint, difficulty in swallowing, and after the most meticulous examination the roentgenologist finds no evidence of obstruction or abnormal constriction or esophagospasm, the patient is dismissed and the doctor who refers the case receives the report, "Nothing abnormal found in the examination of the esophagus." Too infrequently the roentgenologist fails to carry out the detailed study of the esophagus that is indicated in such a case. Long ago various observers, namely, Hickey, Barclay and Manges, pointed out the necessity of the most careful search for any possible abnormality in the esophagus not only varying the consistency of the medium which the patient is given to drink but also examining the patient in the upright, prone and oblique positions, with a careful study of the mucosal relief pattern in order to bring out slight variations or deviations from the normal.

Another factor which mitigates against early diagnosis in neoplasms of the esophagus is that the patient fails to obtain expert advice when the earlier symptoms manifest themselves, and valuable time is lost. McGibbon says that the responsibility for this loss is not due entirely to ignorance, carelessness or fear on the part of patients as not infrequently they have been treated by their medical attendant for nervous spasm or dyspepsia for two or three months before the nature and gravity of the complaint are realized. As proof of this statement, Jackson's records show that of 110 cases of esophagoscopically proven disease of the esophagus, in 87 an inferential diagnosis of neurotic condition had previously been made, and an analysis of a large group of cases reported shows that the average

[1] McGibbon, J. E. G. The clinical manifestations of the spread of carcinoma of the oesophagus observed during life. *Brit. J. Surg.*, July, 1936, *24*, 86–104.

period between the onset of symptoms and diagnosis is almost six months.

The virulence of the disease itself is an added factor in the poor results obtained in treatment of carcinoma of the esophagus. As might be expected in the esophagus as in other parts of the body, the malignant disease varies in type and in behavior. Some observers regard the growths as relatively benign, while others consider the tumors to be of low virulence so long as they are confined to the esophagus itself, but that once they transgress these boundaries their growth is rapid and destructive. Other observers, however, are of the opinion that esophageal neoplasms are very virulent lesions. The virulence of the lesion is emphasized by the fact that the average length of life after the appearance of the first sumptoms in the large group of cases reported by Watson was 10.5 months and after admission to the hospital 4.83 months. Chevalier Jackson, however, states that if patients suffering from carcinoma of the esophagus have an abundance of water and a full allowance of a well-balanced diet, they will survive for at least two years. This rather long survival of patients with malignant lesions of the esophagus should cause roentgenologists to be a little guarded in their statements as to their results with radiation therapy in prolonging life in these cases.

It might be expected that carcinomata of the esophagus situated as they are in proximity to the lymphatic channels would spread quite rapidly. The possible modes of spread of esophageal carcinoma are either by direct extension, lymphatic permeation and embolism, blood stream and implantation, and McGibbon has pointed out that the symptoms and signs of spread by direct extension will naturally depend upon the level of the growth. In its upper third the esophagus is in close contact with the trachea, recurrent laryngeal nerves, carotid arteries and pleurae; in its middle third with the trachea, left bronchus, intercostal arteries, thoracic duct, hemiazygos veins, aortic arch, left subclavian artery, and right pleura; in its lower third, with the left auricle, pericardium, descending thoracic aorta and pleurae. Thus the esophagus in its upper two-thirds is in relation to many important structures, and spread from growths situated in this locality is more apt to give rise to signs and symptoms than from those situated below the tracheal bifurcation. McGibbon found that in an analysis of his cases the most common manifest complication of spread was caused by involvement of the recurrent laryngeal nerves. His findings are in accord with the observations of numerous writers. He has pointed out the rather significant findings in some of his cases, namely, nocturnal cough as a symptom of non-perforating tracheal involvement, and he explains this on the basis that the cough is possibly due to irritation caused by the backward pressure of the trachea on the ulcerating mass when the patient adopts the supine position.

Certain hopeful surgical measures have been instituted comparatively recently in the treatment of this seemingly hopeless disease. The roentgenologist may, by a more careful examination, contribute greatly to the earlier diagnosis in carcinoma of the esophagus. This may be done by following a careful technique, re-examining the patient within a day or two if the first examination is negative, preferably at the time when he is suffering more acutely from the difficulty in swallowing, and above all, he should not give the patient or his physician a false sense of security in his negative reports, but should call attention to the fact that lesions of the esophagus may in their earlier stages be overlooked in the roentgen examination and that the patient should have the benefit of an esophagoscopy. By such an approach we may hope to make an earlier diagnosis in this condition. However, the nature of the disease process itself, the vague symptomatology which the patient manifests and the long period of time elapsing between the earliest minimal difficulty in swallowing and the time the patient consults his physician lend a rather pessimistic outlook in this rather prevalent disease.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. F. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Chicago, Ill., Sept. 13–17, 1937.

American College of Radiology
Secretary, Dr. B. H. Orndoff, 2561 N. Clark Street, Chicago, Ill. Annual meeting: Atlantic City, N. J., June, 1937.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N. J., June 9–11, 1937.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Cincinnati, Ohio, Nov. 30–Dec. 4, 1936.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. Howard H. Ashbury, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut State Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets annually in May. Special meetings may be called by the Chairman.

Radiological Section, Los Angeles County Medical Society
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas. Annual meeting, Baltimore, Md., Nov. 17–20, 1936.

Brooklyn Roentgen Ray Society
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, General Hospital Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. North W. Shetter, 14600 Detroit Ave. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Denver Radiological Club
Secretary, Dr. K. D. A. Allen, 452 Metropolitan Building, Denver, Colorado. Meets on any month having a fifth Monday.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida State Radiological Society
Secretary, Dr. Harold O. Brown, Tampa, Florida. Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. Cesare Gianturco, 602 W. University Ave., Urbana, Ill. Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, Indianapolis, Ind. Meeting held the second Sunday in May annually.

Long Island Radiological Society
Secretary, Dr. S. G. Schenck, 115 Eastern Parkway, Brooklyn, N.Y. Meets at Kings County Med. Soc. Bldg. on third Thursday of each month from October to May, at 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing, Mich. Three meetings a year, Fall, Winter, and Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting named by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

Nebraska State Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday evening of each month.

New England Roentgen Ray Society
Secretary, Dr. E. C. Vogt, 300 Longwood Ave., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

New York Roentgen Society
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N. Y. Three meetings a year—January, May, and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Two day annual meeting held in May or June. Time and place of next meeting to be announced later.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Roentgen Ray Society
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Department of Roentgenology Staff Meeting
Secretary, Dr C. B. Peirce, University Hospital, Ann Arbor, Mich. Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. F. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to Nov. incl. for scientific discussions.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Sociedad Española de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, II.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. G. Gatoschi, Str. Isvor 14–16, Bucarest.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology in Sweden
Meets in Stockholm

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

ILLINOIS RADIOLOGICAL SOCIETY

The quarterly meeting of the Illinois Radiological Society was held in Bloomington, at the Hotel Rogers on Sunday, July 26. At a film clinic interesting cases were presented by Drs. Halley, Rypins, and Henley. Dr. P. G. Melnick and Dr. Albert Bachem discussed the "Time Factor in the Irradiation of Malignant Tumors" and Dr. A. H. Arneson presented a paper on "Radiation Therapy in the Treatment of Malignant Diseases."

The Illinois Radiological Society and the Chicago Roentgen Ray Society held a joint meeting at Starved Rock State Park, Illinois, on Sunday, October 11. In addition to the discussion of several interesting cases the following program was presented: "The Diagnosis of Chronic Cholecystitis, by Dr. W. H. Cole, Professor of Surgery, University of Illinois; "The Illinois Occupational Disease Law" by Oliver E. Mount, Chairman of the Committee on Occupational Disease, Illinois Manufacturers' Association.

REFERENCES TO MEDICAL LITERATURE

Frequently physicians find it difficult to obtain references to past medical literature which will help them in preparing a medical paper. They would like such references if they could get them. The largest medical library in the United States is the Surgeon General's Library in Washington. The second largest, we believe, is in the New York Academy of Medicine. The services of the Academy library is available at all times. The American Medical Editors' and Authors' Association, through its Director, Dr. Harold Hays, 133 East 58th Street, New York City, can arrange to supply references or abstracts on any medical subject. This service is available to any doctor. Please write to Dr. Hays for information if you are interested. The cost will depend upon how much information is desired. The original bill rendered by the Academy will be sent to the physician making inquiry. The Association makes no charge. This is but one of the services this Association wishes to render to doctors.

CONVENTION OF THE GERMAN ROENTGEN SOCIETY

This year's convention of the German roentgenologists was held at Wiesbaden in April; the first session was held in conjunction with the internists, the joint meeting representing the final session of the latter group. Kalk, clinician and Knothe, roentgenologist, submitted their respective papers on "Inflammatory Diseases of the Colon." Kalk said that treatment of a single section of the intestinal tract was most unsatisfactory since the local alterations are often only secondary or, conversely, may be followed by modifications in other organs. He pointed out the efficacy in colitis gravis of alterative anaphylaxis treatment with horse serum and plenty of vitamins. He cautioned against enemas of various kinds. Kalk considers true colica mucosa a neurosis of the secretory nerves.

In the roentgenologic paper, Knothe reviewed the progress of diagnostic methods. Roentgen examination must be competently carried out and each of a number of details must be observed. The roentgenologic picture in the three stages of colitis is sufficiently characteristic. Of particular importance is the determination of the seat and the extent of the pathologic changes. Tuberculosis too is plainly recognizable. Not infrequently there exists a considerable discrepancy between the clinical picture and the roentgenologic appearances.

Alexander of Agra next submitted a paper on the "Diagnosis of Tuberculous Cavities." There are important differences between the round cavities which originate from an early infiltrate in the pulmonary tissue of normal elasticity and the thick walled tertiary cavities and their accompanying symptoms (pleural induration, atelectasis). Chaoul of Berlin, roentgenologist of the Sauerbruch clinic, demonstrated how by means of tomograms the large bronchi can be given an isolated representation. By separation of the lung roentgenograms into a series that portrays various sectional layers the number, situation, shape and size of tuberculous cavities can be established.

The third paper, "Short Wave Therapy in

Internal Medicine," was delivered by Schliephake of Giessen, who discussed the results of research on the distribution of short wave energy in homogeneous and layered mediums. The depth and intensity of the effect is dependent on the wavelength, on the size of the electrodes and on their distance from the body surface. The heat effect from short wave therapy is of trivial and distinctly secondary importance when compared to that of long wave diathermy. Methods for accurate measurement of function and determination of dosage have yet to be evolved. Short wave therapy will be indicated principally in suppurating infections (such as furuncles, carbuncle, abscesses and gynecologic inflammations), rheumatic-arthritic disorders and certain circulatory disturbances. For the last named a weak energy is indicated, but for rheumatic joints considerable energy should be used. Numerous astonishing successes in cases of pulmonary abscess have been authenticated. Schliephake holds faulty dosage responsible for lack of success in inflammatory diseases. Too weak energy will be ineffective, whereas overdosing will tend to break down the leukocytic bulwark of defense. Knowledge of this sort is essential if short wave therapy is to be successfully carried out. Injudicious application has unfortunately tended to give the method a bad name.

Holthusen of Hamburg submitted a report on "Prevention of Injuries from Roentgen Rays." Among possible harmful after-effects may be mentioned changes in the connective tissues, diminished reproductive function and increased susceptibility to infection in various tissues. Just as it is impossible to estimate the size of the dosage that will destroy a tumor, so it is likewise impossible to delimit the severity of ill effects incurred by the treatment. The critical region in Coutard and radium irradiation lies between two and one-half and six erythema doses, or between 4,500 and 11,000 roentgens. The cause of this latitude of efficacy is to be found in the vast variation of individual sensitivity rather than in the fluctuations of dosage. The total dosage for single areas of tissue, especially with regard to the overlapping of the ray cones, is to be considered a possible source of injury. The circumstances may also be complicated by the combined use of radium and roentgen irradiation. It has been assumed for some time that the musculature and the glandular functions are particularly sensitive. Permanent epilation by roentgen rays is contraindicated as too hazardous. Particular caution should be exercised when persons in the growing stage are subjected to the rays.

Of the technical papers, that of Ziedses des Plantes of Utrecht on "Seroscopy" is particularly worthy of mention. Seroscopy is a roentgenographic procedure which makes it possible, by means of numerous exposures, to examine an endless series of consecutive parallel planes. Thanks to this ingenious device, the object, a skull for example, pictures of which are taken from various angles, may be examined according to layers, as it were, just as a preparation may be microscopically studied by turning of the micrometer screw.

In his discussion of "Artificial Radioactivity" von Bothe of Heidelberg considered the risk involved in the use of neutron rays, the formation of gamma radiation of 2,000 kilovolts by the absorption of neutrons in water, and the production of artificial radioactivity by means of artificial transformation of the elements. The neutron rays appear to be extremely powerful from a biologic standpoint; rats can be killed by them. This type of irradiation possesses double the hardness of gamma irradiation.—*J. Am. M. Ass.*, Sept. 19, 1936, *107*, 978.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Clinical Tuberculosis. Edited by Benjamin Goldberg, M.D., F.A.C.P., F.A.P.H.A., Associate Professor of Medicine, University of Illinois College of Medicine, Honorary Professor of Medicine, National University of Mexico; Formerly Director of the City of Chicago Municipal Tuberculosis Sanitarium. With the collaboration of 33 contributors. Two volumes. Illustrated with over 640 halftone and line engravings and 9 full-page color plates. Cloth. Price, $22.00. Philadelphia: F. A. Davis Co., 1935.

It is impossible to review chapter by chapter these two volumes. They will be discussed from a general standpoint and those chapters which merit discussion and are of more general interest will be more fully mentioned. The work is a compilation of the writings of a number of men who have developed a special interest in some field of tuberculosis, and in general attempts to deal with the clinical, pathological and immunological aspects of tuberculosis. The discussion is not limited alone to the pulmonary manifestations of the disease but treats of other forms of tuberculous infection.

Those chapters which deal with the nonpulmonary forms of tuberculosis give the impression of having been held in the background and in no degree answer the demand of a work of encyclopedic scope as set forth by the Editor. They are in the main too brief and do not completely cover the field. Those chapters on renal, and bone and joint tuberculosis, while good as far as they go, are too brief. In contrast a chapter on tuberculous meningitis consumes over sixty pages.

It is unfortunate that the chapter by Clerf on bronchoscopy was in press before knowledge of tuberculous tracheobronchitis was better developed.

The chapter on classification by Ornstein and Ulmar, while ably executed and undoubtedly containing much that is true, will, it is felt, lead many to a false sense of security in the management of the tuberculous. This classification distinguishes a benign from a more destructive type of disease. The basis of differentiation has its foundation on the history, the roentgen findings and the subsequent clinical course. It does not seem that a classification which must wait upon the subsequent increase or decrease of the disease process for its final decision as to type is of great value. The idea is of interest as a pathological-clinical explanation of a disease process but its use as a clinical classification leaves much to be desired.

In general, that part of the work which deals with surgery is good and is by far the best section. The chapter on selective apical collapse by Coryllos is good. It seems, however, that its title somewhat belies its true content. Apical plombage is one of the less important procedures in the surgery of tuberculosis and has been much too fully discussed. However, that portion of the chapter which deals with apicolysis and apical thoracoplasty is excellent and sets forth those principles in use today of aiming to collapse only diseased areas, leaving the normal lung to function. In truth the chapter treats well of the present day thoracoplasty. The indications given for such procedure in this chapter are, however, too far reaching in that they aim to use more drastic surgery before the simpler procedures have been attempted. On the whole, this chapter is far more modern in its concept than the chapter written by the late Hedblom, which while excellent in the historical and general concept deals with a type of thoracoplasty which is rapidly being discarded in this country.

The chapter on pathological physiology of the tuberculous lung by Coryllos is good in part. It is unfortunate, however, that the writer did not confine his observations to the respiratory physiology and a discussion of changes in these processes in the diseased state. He has elected to discuss in some detail his idea on the closure of the tuberculous pulmonary cavity. The impression gained is that the mechanism of closure which he has championed is a proven principle. It is the opinion of the reviewer that there are many who disagree. The study on the changes occurring in the gaseous content of the pneumothorax pocket is well worth reading.

The chapters by Matson on pneumothorax, pneumonolysis and phrenic-nerve surgery are excellent. His writing grasps the idea of in-

struction; not only does he give knowledge gained from a long experience on indications and methods but his results from such treatment are closely evaluated and discussed.

The chapter on epidemiology is good. Those dealing with pathology and immunology, while excellent in themselves, do not seem to strike the constructive notes in these fields which today should be contained in a work of this type.

The chapter on X-ray findings by Potter it is felt is one of the best parts of the compilation. There has been by this author a very valiant and successful attempt to explain roentgen interpretation on the basis of the pathological process present in the various manifestations of pulmonary disease. He has given a concise and excellent guide in the interpretation of the chest roentgenogram. He has sensed the failure of such a classification as presented by Ornstein and Ulmar and has substituted in its a place a workable and valuable classification.

The fact that these volumes are the product of various authors on different phrases of tuberculosis has not, it would appear, worked to the fullest advantage of the publication. While such a system is oftentimes productive of much that is good, it is equally true that it may give rise to a confusion which blurs the central idea as it was originally conceived. There is, it seems, a grave danger that such a compilation may be so tainted with individual scientific hobbies, as yet not definitely established, that much which is fundamental in our knowledge is supplanted by interesting intellectual theories. This fault, it appears, has not been wholly surmounted in these volumes. There are many excellent chapters from which the student or specialist may profit, but there are an equal number over which time will be consumed and little reward gained. The idea of rendering a text which will bring out the salient ideas relative to certain topics has been lost and has been replaced by an individualism of ideas seldom seen in a work of encyclopedic scope. While such writings are of great value and interest in periodicals it would seem that their place in a textbook should be limited.

William M. Tuttle

Dental Roentgenology. By LeRoy M. Ennis, D.D.S., Assistant Professor of Roentgenology in the Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania; Instructor in Dental Roentgenology, in the Graduate School of Medicine, University of Pennsylvania, etc. Second edition, thoroughly revised. Cloth. Price, $6.50. Pp. 351, with 693 illustrations. Philadelphia: Lea and Febiger, 1936.

This second edition has been thoroughly revised and additions made in accordance with the advancement in dental roentgenology since the publication of the first edition in 1931.

The most outstanding revisions are: The description of the newer type of dental roentgen equipment; the supplementing of the extraoral sinus examination with occlusal films; the addition to the extraoral technique of the superior view of the sphenoidal sinus and the superior-inferior view of the malar and zygomatic bones, all to be found in Chapter III; a very comprehensive discussion of the nasopalatine canals, maxillary sinus, nasolacrymal canal and nutrient canals of the mandible in Chapter VII, and mention of the torus mandibularis in Chapter VIII. Many new illustrations have been added. The fine quality of reproduction of films and photographs is maintained in this edition. The material is presented in a concise yet thorough manner, and the book may well be recommended as an asset to anyone interested in the roentgen examination of the teeth and adjacent structures.

H. F. Doane

Kurzwellentherapie. Von Dr. Josef Kowarschik, Primararzt und Vorstand des Institutes für physikalische Therapie im Krankenhaus der stadt Wien. Paper, price, RM. 9.60; bound, RM. 10.80. Pp. 140, with 147 illustrations. Wien: Julius Springer, 1936.

This work consists primarily of a discussion of short wave therapy; the mechanisms involved, the methods of treatment and the results observed. The fore part of the book describes very completely the physics of the short wave, including a discussion of the electrical current involved, the discharged current, and the various types of short wave apparatus. The technique of short wave treatment is of special interest since it includes the methods of applying the electrodes to the various parts of the body.

The similar selective effect, which was observed in organized tissue, has been observed with microscopic and ultramicroscopic systems.

The effect on bacteria and bloods cells is not great and depends largely on factors of temperature and time. In man, short wave treatment brings about an active hyperemia of the epidermis with the formation of perspiration, the blood pressure drops and the pulse and respiratory frequency increases. Short wave treatment prevents the proper physical development of animals, as shown by studies with white rats, and has a marked ability to kill plant life in a relatively short time.

The effect of short wave therapy on carcinoma and sarcoma depend, to a large extent, on their type and location, and is, perhaps, not greater than other heat effects. The damage to tissue caused by short waves depends on the type of treatment.

In order to obtain the best results the short waves must be correctly applied. The writer shows with description and illustrations various methods of applying the electrodes in order to obtain the desired results. A discussion of the results is included.

K. Pierre Dozois

Eight Clinical Lessons. By F. Gallart Monés. Fourth Series. Pp. 148, with 65 illustrations. Barcelona: Salvat Editores, 1936.

This new series of clinical lessons by Gallart Monés, of the School of Digestive Pathology of the Hospital of the Holy Cross and Saint Paul (Barcelona) is a worthy successor to the three previous series. The printing is good, the illustrations are excellent, and the roentgenograms are not only well selected but beautifully reproduced. Each lesson or chapter deals with a distinct condition, as follows: cancer of the esophagus, gastrointestinal hemorrhage in abdominal pathology, tuberculous peritonitis, perivisceritis, visceroptosis, the diagnosis of cancer of the colon, the diagnosis of primary cancer of the pancreas, and digestive syndromes in renal lithiasis. A valuable feature of these lessons is that the author attempts to correlate the clinical with the pathologic and roentgenologic features. If only from the standpoint of their presentation these lessons are well worth reading.

A. U. Desjardins

DEPARTMENT OF TECHNIQUE

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DEVICE FOR ROENTGENOGRAPHY OF THE HEAD IN THE ERECT POSTURE*

By MAURICE RONA, M.D.
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WHEN roentgenographing the sinuses we many times feel uncertain whether the patient's head remains in the position in which it was placed. This uncertainty is a common fault with all the methods where

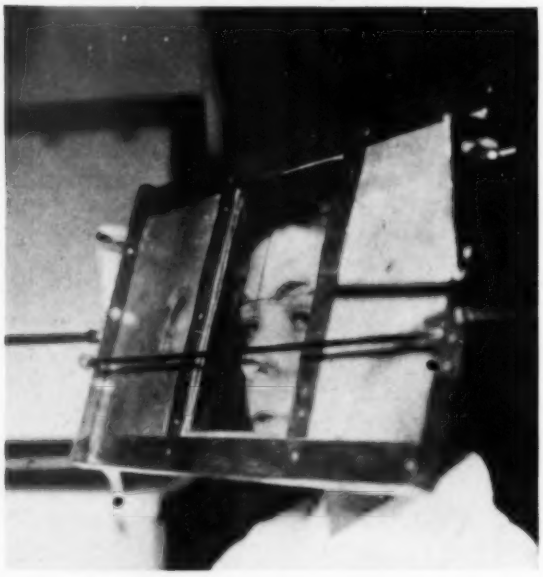

Fig. 1. Forehead-nose position.

the forehead or the face rests on a horizontal cassette. Minor deviations and tiltings from the accurate position are almost impossible to detect after the positioning is finished.

The desire to avoid these uncertainties and to correct these faults prompted me to design the device I am describing, which has given me satisfactory results during the last two years. I found it serviceable in roentgenographing the nasal sinuses, the optic foramina, the petrous bones, the mastoids, and the various facial bones. In my belief it is superior to the ordinary sinus blocks now generally used, for the following reasons:

The patient sits comfortably, a large surface of his head is supported, therefore he is willing and able to cooperate.

The technician sees the exact position of the patient's head, he is able to center the desired part accurately and make adjustments at all times.

The technique makes the injection of opaque materials easy, and the detection of fluid levels possible.

The device is easily moved, adjusted and angled; it is adaptable for various parts of the head in various positions.

Description of the Device. The device consists of two main parts: (1) the stationary plate, and (2) a movable tray. The stationary plate has the double function of supporting the patient's head, and carrying the movable tray by the aid of rods and sleeves. The movable tray carries the cassette, and it may be approached and angled towards the face. Vertical adjustment as to height is obtained through the stationary plate which is raised or lowered in a suitable upright stand; horizontal approach and angulation to the extent of 25° is gained by the movable tray. The latter is divided across its base into three sections. The middle section is a celluloid window with a hairline-cross in its center, the two side sections are shielded with lead and allow two exposures on one 8″ × 10″ film.

Technique. The sinus device is put in an upright stand, the patient seated on a chair with his back towards the stand and the roentgen tube. The stationary plate is adjusted as to height so that the occiput rests in the circular window of the plate. The patient's head is bent to the desired angle, the movable tray tilted 25° and advanced

* Shown at the Meeting of the Radiological Society of New Jersey, June, 1936.

until it touches the skin. The field is inspected through the celluloid window, and corrections as to position and centering are made with the aid of the hairlines. Each half of the cassette is marked with a piece of adhesive bearing the numbers 1 and 2, respectively. The cassette is inserted with No. 1 covering the window, and the exposure made while the patient holds his breath. Adhesive No. 1 is removed, the cassette taken out, the head of the patient adjusted for another position, the cassette replaced, exposing now field No. 2. All exposures are made with the tube remaining stationary, the central ray being horizontal, entering the posterior part of the head and emerging at some anterior part.

Special Techniques.

Forehead-Nose (Caldwell) Position. Tray angled 25°. Sagittal suture in line with the central ray. Head bent forward until forehead and nose touch the window. Ray passes through upper occipital region to frontal region. Center: root of the nose.

Nose-Chin (Waters) Position. Tray angled 25°. Sagittal suture in line with the central ray. Head bent backwards until the chin and the tip of the nose touch the tray. Mouth of the patient wide open. Ray enters the vertex emerging through the mouth. Center: alveolar process of the upper incisors.

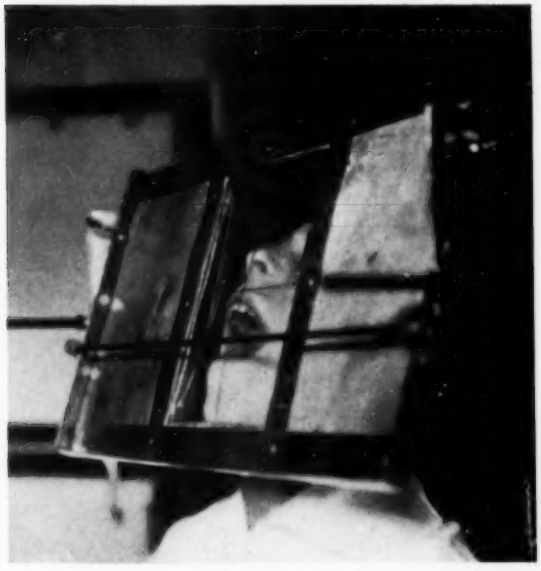

Fig. 2. Nose-chin position.

Fig. 3. Lateral position.

Oblique (Rhese) Position. Tray 25°.* Sagittal suture forms 53° with the central ray. Head bent forward until the eyebrow, the zygoma and the side of the nose touch the tray. Incidence of the ray through the opposite parietal tuber to the orbit. Center: the outer canthus.

Oblique (Stenvers) Position. Tray 25°.* Sagittal suture forms 45° with the central ray. Head bent forward until the forehead touches the tray. Ray goes from the mastoid region of the same side to the temporal fossa. Center: (in projection) the outer part of the temporal fossa.

Lateral. Tray vertical. Sagittal suture forms 90° with the central ray and is kept parallel with the tray. Ray goes from temporal to temporal fossa, the lower middle portion of which is centered.

CONCLUSIONS

A novel device is described, the merits of which are comfort for the patient, ease of handling for the technician, exactness and accuracy in technique, saving in time and materials. The technique for some parts of the head is given. Other positions are easily obtainable.

* Tray may be vertical.

GRAPHIC-PARALLAX METHOD OF FOREIGN BODY LOCALIZATION

A SIMPLE METHOD FOR EXACT, THREE-DIMENSIONAL LOCALIZATION OF FOREIGN BODIES FOR SURGICAL REMOVAL

By W. T. SHAVER, M.D., *and* J. F. SIMPSON
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THE apparatus consists of a frame graduated in square inches, to fit over the patient's body and a graphic wall chart for finding the position of the foreign body (Figs. 1 and 2).

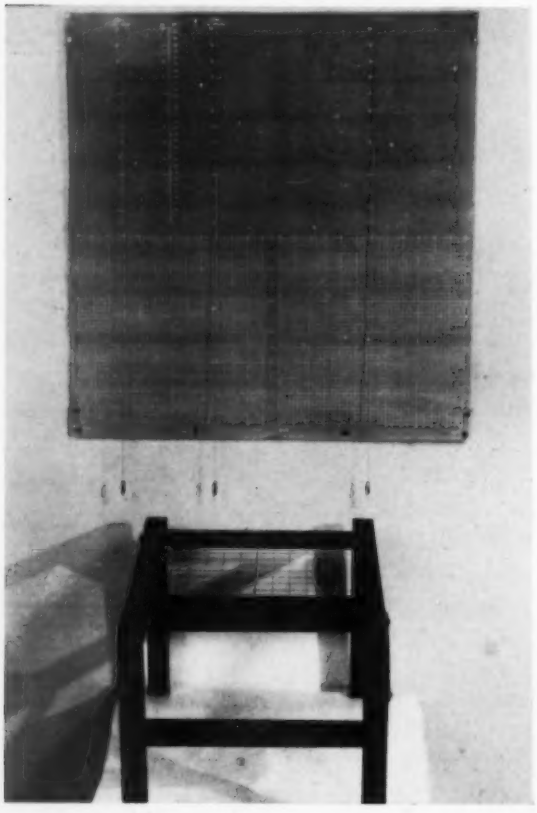

FIG. 1.

Roentgenoscopic Procedure. Place the patient flat on the roentgenoscopic table, face up or face down. Place graduated frame across the patient's body with fluoroscopic screen above and close to graduated frame. By closing shutters to a very small opening, center tube on midline and on 3 inch line toward the patient's head. (If fluoroscopic screen is rigidly mounted so that there is no horizontal motion independent of the tube, centering can be facilitated when this point in the procedure is reached by making a cross mark with glass marking pencil on upper surface of lead glass fluoroscopic screen cover, this mark then being later used for centering on graduated frame.) Open shutters and note position of shadow of the foreign body in relation to graduations of frame, toward head or foot from center and toward right or left of midline. Now shift tube 6 inches toward foot, centering on midline as before and on 3 inch line toward foot from center of graduated frame. Open shutters and note second position of shadow of foreign body. Having noted the two positions of the shadow with 6 inch tube shift, the wall chart is now used to obtain true position of the foreign body. Move cord suspended from "first exposure" to position on lower line of chart corresponding to first position of shadow of the foreign body. Move cord suspended at "second exposure" to position on chart corresponding to second position of shadow. The cords represent the rays encountering the foreign body and casting the shadows. Where the two cords cross on the graduated chart is the true position of the foreign body in two dimensions, depth and toward head or foot from the center of graduated frame. The third cord on the chart is moved to right or left of midline, corresponding to the position of the shadow. Where this cord crosses the predetermined depth line on the chart is the true position to right or left, giving the third dimension. Mark the patient's skin

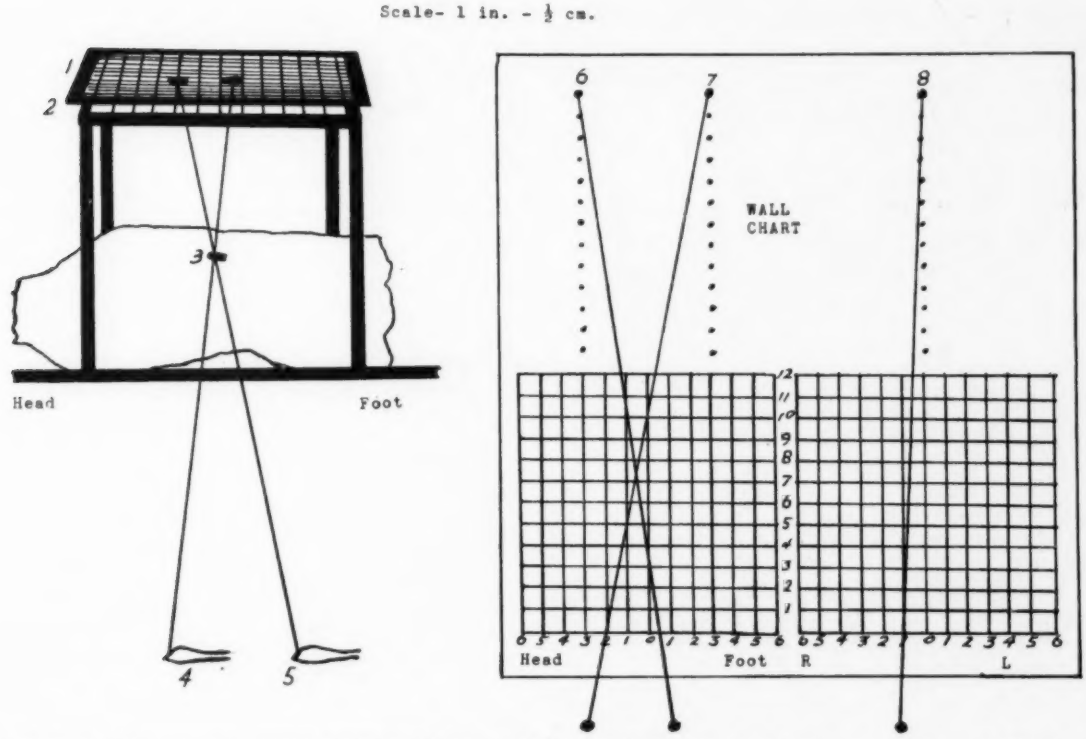

Fig. 2. 1. Fluoroscopic screen showing shadows of foreign body and graduations on frame. 2. Graduated frame. 3. Foreign Body. 4. Tube position, first exposure. 5. Tube position, second exposure. 6. Pivot point of cord for first exposure. 7. Pivot point of cord for second exposure. 8. Pivot point of cord for showing position to right or left. The cords on wall chart represent the rays encountering foreign body.

through graduated frame at indicated position. Knowing the depth of the foreign body below graduated frame it is now necessary to measure distance from frame to patient's skin mark and subtract same from total, the remainder being the depth below skin mark.

Roentgenographic Procedure. With the aid of the fluoroscopic screen center for first exposure as described above. Lock or hold tube in position. Raise roentgenoscopic screen and lay cassette or film holder on graduated frame. Make first exposure. Shift exactly 6 inches toward foot and make second exposure. Same film may be used for both exposures or separate films used for first and second. Having noted the positions of the two shadows,

Fig. 3.

Fig. 4.

the procedure with wall chart is as explained above.

Example: First exposure: ½ inch toward foot and 1 inch to right.
Second exposure: 2 inches toward head and 1 inch to right.

With above figures the chart indicates approximately ½ inch toward head and 7¼ inches deep, and ¾ inches to right at 7¼ inch depth.

Note: If the tube focal spot to frame distance varies from 25 inches a corresponding change in position of pivot points of cords on wall chart must be made. Careful centering of the tube is essential to accuracy.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Fellows, Haynes Harold. Value of the fluroscope in pulmonary tuberculosis case-finding. *Am. J. Pub. Health*, Feb., 1935, *25*, 109–112.

An experiment to determine the value of the roentgenoscope for the detection of tuberculosis having resulted in the finding of 37 individuals, acceptable for employment after the usual physical examination, to have definite tuberculosis, the procedure has been continued. In a five year period 17,765 applicants for employment have been so examined, of whom 244 showed definite tuberculosis on roentgenoscopic study, later confirmed. The method has demonstrated its value in accuracy, rapidity and economy.—*W. R. Brooksher.*

Hruby, Allan J., and Joannides, Minas. A topographical localization of pulmonary lesions. *Am. Rev. Tuberc.*, 1934, *29*, 310–312.

A method for topographical localization of pulmonary lesions, which is in use in the Pneumothorax Clinic, Municipal Tuberculosis Sanitarium, Chicago, Illinois, is described. A standardized routine of drawing lines is used which divides the chest into about 25 blocks each with a number. The numbering is systematized. The location and usual physical signs are recorded on a special form on the specific portion of each block on the plate. This method has helped the authors to localize pathological lesions in the lung, and maintain an accurate topographic visualization.—*L. H. Osmond.*

Mintz, Nathan. Fibroma of the pleura. *J. Mt. Sinai Hosp., New York*, May–June, 1935, *2*, 38–43.

Report is made of a case of fibroma of the pleura with necropsy findings. The lesion may be suspected in an individual with an intrathoracic mass presenting a sharp outline on the roentgenogram, enlarging at an exceedingly slow rate without the production of symptoms. Cough, sputum or hemoptysis may be absent because there is no invasion of pulmonic tissue. The fairly characteristic roentgenological picture of a nearly spherical contour, sharp outline and marked density, may be obscured by effusion or adhesions.—*W. R. Brooksher.*

Westermark, Nils. The situation of the pleural exudate in obstructive atelectasis of the lung. *Acta radiol.*, 1935, *16*, 345–353.

The author describes and illustrates with roentgenograms 18 cases of obstruction atelectasis with free pleural exudate in which the upper border ran obliquely laterally and downward instead of as usual medially and downward. The position of the exudate was dependent to some extent on its size and the localization of the obstructive atelectasis. It was possible to determine the site of the obstruction of the bronchus by the localization of the exudate.

The paradoxical position of the exudate in massive collapse or obstructive atelectasis of the lung is due to the changed pressure relations in this disease. It is a manifestation of equalization of the increased negative pressure in the pleural cavity as is the displacement of the heart and mediastinum toward the affected side, the elevation of the diaphragm and the retraction of the wall of the thorax, all of which are more or less marked symptoms in this disease.—*Audrey G. Morgan.*

Joannides, Minas. The displacement of intrathoracic viscera resulting from pathological processes in the lung. *Am. Rev. Tuberc.*, March, 1934, *29*, 313–328.

An analysis of the causes of diaphragmatic rise, dextroposition and sinistroposition of the heart and mediastinum is made. Mediastinal displacement does not presuppose the presence of pleuropulmonary adhesions. In fact, in the author's experience with 250 cases of such displacements, he is convinced that the potential vacuum resulting from sclerosis of one lung has been instrumental in bringing this about, and that it should not be considered as a contraindication for pneumothorax collapse. Mediastinal displacement may be corrected by collapse therapy, and thus the pulmonary reserve of the good lung may be preserved.

In cases of hydropneumothorax an inspira-

tory mediastinal displacement toward the affected side may cause a rise of the fluid level from 1 to 5 cm. The diaphragm reacts normally in these cases, and the degree of elevation represents the difference between the inspiratory contraction of the diaphragm and the inspiratory shift of the mediastinum towards the affected side plus a very slight pulmonary expansion. It is believed that variation of mediastinal displacement with inspiration and expiration depends upon the intrapleural pressure at the time of the examination. If the intrapleural pressures are high one would expect an immobile mediastinum at inspiration. If the intrapleural pressures are low, one may expect a shift toward the affected side. Mediastinal mobility may be used as a prognostic sign in empyema. The greater the motion of the mediastinum in empyema, the better the chance of curing the patient (Lilienthal). A yielding mediastinum may sometimes cause confusion, in that with apparently low intrathoracic pressures excessive displacement of the mediastinum or even mediastinal hernia may result during artificial pneumothorax. Roentgen studies of such patients will prevent such a difficulty.

Mediastinal displacement may occur in chronic as well as acute conditions that cause an imbalance of volume or pressure between the two hemithoraces. Among the acute conditions, lobar pneumonia and massive atelectasis of the lung are the most common. Any chronic condition that causes a unilateral pulmonary sclerosis will result in a mediastinal shift or a diaphragmatic rise. The diaphragmatic rise of an otherwise normal hemidiaphragm is also a compensatory measure to balance differences in volume. This is more likely to be noticed when there is a decreased mobility of the mediastinum.—*L. H. Osmond.*

Saul, W. Aufhellungen an der Oberfläche von Pneumothoraxlungen im Röntgenbild. (Translucent areas on the surface of the lung in pneumothorax.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 580.

Saul classifies the various types of translucent areas (bubbles) that may occur in pneumothorax and states their cause and importance and shows how the clinical course and roentgen findings are in accord with each other. —*E. T. Leddy.*

Hetherington, H. W., McPhedran, F. M., Landis, H. R. M., and Opie, E. L. A further study of tuberculosis in public-school children. *Am. Rev. Tuberc.*, Feb., 1934, *29*, 142–169.

A study of public-school children in Philadelphia has been continued in order to confirm previous observations on the incidence among them of tuberculous infection as shown by the tuberculin test and of various tuberculous lesions as shown by roentgen examination.

Additional tuberculin tests in two schools in Philadelphia confirm the high incidence of tuberculous infection previously reported. In the age-groups fifteen to nineteen years, 79.6 per cent of white boys, 87.9 per cent of white girls, 87.9 per cent of colored boys and 86.4 per cent of colored girls reacted to tuberculin.

The incidence of tuberculous lesions that threaten to undermine health was approximately 0.3 per cent in white children five to eleven years of age, and more than five times as frequent in colored children of the same ages. The incidence of serious tuberculous lesions in children twelve to twenty years of age was 1.0 per cent for white boys and 2.3 per cent for white girls.

The need of prophylactic care for school children with significant latent lesions is not generally recognized. The value of treatment in open-air classes and preventoria can be determined only by long-continued observation of large groups of children, with accurate diagnoses and adequate controls. Conditions in the schools reported here have not made possible the collection of information concerning the value of prophylactic care within the school system. Nevertheless, it is reasonable to suppose that measures of established value in arresting clinical tuberculosis will prevent the development of latent into clinical disease, if adequately applied to appropriate subjects.—*L. H. Osmond.*

Wood, W. Burton, and Gloyne, S. Roodhouse. Pulmonary asbestosis. *Lancet*, Dec. 22, 1934, *2*, 1383–1385.

One hundred cases of pulmonary asbestosis are reported of which 67 cases were in women. The shortest exposure was six months (2 cases) and the longest fifteen years.

Diagnosis is based upon (*a*) typical appearance of roentgenograms of the chest, (*b*) symp-

toms and physical signs of fibrosis, and (*c*) presence of asbestosis bodies in the sputum. The roentgenograms of the chest show evidence of a fibrosis of the fine type affecting the lower two-thirds of the lung fields. The symptoms are stubborn cough with little expectoration, discomfort or dull pain in the chest, occasionally perhaps a streak of blood in the phlegm and above all dyspnea. The exact diagnostic significance of asbestosis bodies in the sputum is doubtful.

Histologically the disease appears to begin in the respiratory bronchioles and alveolar ducts, and is characterized by a cellular reaction of mononuclear phagocytes and asbestosis giant cells followed by the formation of reticular fibrosis.

There was an incidence of 21 per cent in this group showing active tuberculosis complicating pulmonary asbestosis. The authors state that whatever the added risk of tuberculosis may be in asbestosis, it is less than that associated with silicosis.—*L. H. Osmond.*

Westermark, Nils. Entwicklung und Vorkommen von Atelektase bei Lungentuberkulose. (Occurrence and development of atelectasis in pulmonary tuberculosis.) *Acta radiol.*, 1935, *16*, 531–544.

Obstruction atelectasis is a very common complication in pulmonary tuberculosis and is of great importance both in the interpretation of the roentgen picture and in the course and treatment of the disease. In atelectasis the lung tissue is cut off from the external air by occlusion of one or more of its bronchi and loses its air content by absorption and collapses. The bronchi may be occluded by changes in the lumen of the bronchi, such as blocking of the lumen by secretion, blood, pus, etc., by changes in the walls of the bronchi such as tuberculous granulations or by causes outside the bronchi, such as pressure from the diseased lymph nodes.

Obstruction atelectasis gives a massive, homogeneous, wedge-shaped shadow, the boundary of which is often concave. In order to see it roentgenograms should be taken in the lateral projection, in which the ramifications of the bronchi in the lungs can be seen. The atelectasis pulls the heart and mediastinum toward the diseased side and causes a respiratory oscillation of these organs as well as a lowering and retraction of the wall of the thorax and an elevation of the diaphragm due to the decreased respiratory movement. When there is a pleural effusion it occupies paradoxical positions. Bronchography often shows multiple occlusions.—*Audrey G. Morgan.*

Reviglio, G. M. Un caso di neurinoma intratoracico. (A case of intrathoracic neurinoma.) *Arch. di radiol.*, Jan.–Feb., 1935, *11*, 29–35.

Neurinomata are benign tumors of slow development resulting from proliferation of the cells of Schwann's sheath. They differ in this from the connective tissue new-growths that develop along the course of nerves. They generally develop in young individuals which has given rise to the theory that they are congenital. They have been seen in old individuals, however. Their site of predilection is the foramina of exit of the cranial and spinal nerves.

The author describes a case in a child six years of age who came for treatment during convalescence from influenza. The tumor was discovered by chance on roentgen examination of the thorax. There was an intensely opaque shadow in the left apex and the lung design was entirely abolished at this place. It was semicircular with a smooth outline following the upper margin of the first rib. The trachea was not displaced and there were no evidences of enlarged lymph glands. There was no pulsation in the mass and no appreciable movement of it on coughing or deep inspiration. It was about the size of a pigeon's egg and was in the posterior part of the apical region, extending from the first to the third dorsal vertebrae with its base along the spinal column. It did not change position with changes in the position of the patient or with changes in intrathoracic pressure. The blood picture and basal metabolism were normal. Tests for echinococcus cyst were negative. The tumor had caused no symptoms. The author made a probable diagnosis of intrathoracic neurinoma developing at the point of exit of the second left spinal nerve. It has not been possible to make a histological diagnosis. The child has been under observation for four years and there have been no symptoms from the tumor and it has not changed appreciably in size or appearance. These tumors are evidently capable of transmitting nerve impulses so there is no interruption of nerve conduction from their presence. In some cases they cause intense pain and in some cases after a long period of quiescence they grow rapidly. They have been successfully extirpated in some cases.—*Audrey G. Morgan.*

Zanetti, Serse. Il valore dell'indagine radiologica nella cura chirurgica della tubercolosi polmonare. (The value of roentgen examination in the surgical treatment of pulmonary tuberculosis.) *Radiol. med.*, May, 1935, *22*, 425–451.

The author emphasizes the great value of roentgen examination in the surgery of pulmonary tuberculosis. It is of value in diagnosis in judging the type of the anatomical lesion, in treatment in determining the character of the operation to be performed in the individual case and in prognosis in following up the progress of the cure.

The chief types of operation in pulmonary tuberculosis are extirpation of the phrenic nerve, intrapleural or extrapleural pneumolysis and thoracoplasty. Extirpation of the phrenic is indicated chiefly in fibrous forms with a tendency to spontaneous retraction. In addition to the type of the lesion it is very important to know its site and extent and this is best determined by roentgen examination. The prospects of cure are particularly good in circumscribed lesions such as solitary cavities. If the lesions are diffuse, the elasticity of the lung is impaired and the operation is less effective. This operation is frequently used as a preliminary step to the performance of more radical operations. It is as a rule not to be recommended in bilateral lesions. Roentgen examination is particularly valuable in studying the immobility and elevation of the diaphragm after the operation.

Intrapleural pneumolysis is particularly indicated in cases with a single adhesion which is exercising traction on a cavity which cannot be compressed by pneumothorax. It requires roentgen examination to show accurately the site, form and extent of such adhesions. Extrapleural apicolysis consists in detaching the parietal fold of the pleura from the wall of the thorax and introducing some filling material into the space such as paraffin containing bismuth to render it opaque to roentgen rays. This opacity, however, has the disadvantage of masking the underlying parenchymatous lesions. The best solution would be to give the paraffin just the right opacity to show its site without its being opaque enough to mask the underlying lesions. This is difficult but not impossible, as shown by one case described and illustrated by the author. The results should be followed after operation by roentgen examination.

Thoracoplasty is indicated in cases in which pneumothorax cannot be performed and more specifically in productive fibrous or fibro-ulcerous forms. These lesions in themselves have a tendency to cause retraction of the wall of the thorax and the operation assists this natural process. The operation may also be used in mixed productive and exudative types if the former form predominates. It may also be used in cases associated with mild tuberculosis in other organs, as the bones, kidneys, larynx, etc. It is absolutely contraindicated in rapidly progressive forms with rapid decline of strength and high temperature, and in extensive bilateral lesions even if they are fibrous, and in severe and extensive tuberculosis of other organs. The roentgenologist must study all the signs with great care in order to determine the indications in each individual case. The most absolute cooperation between roentgenologist and clinician is necessary, however, in order to obtain the best results.

Sixteen cases in which these various operations were used are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Claessen, Gunnlaugur. On echinococcus in the lung. *Acta radiol.*, 1935, *16*, 601–615.

The author describes a case of primary hydatid cyst of the lung. This localization is extremely rare in Iceland though in other countries in which echinococcus is endemic about 18 per cent of the cases are in the lung. The causes of this peculiarity are not known. The author describes in detail the clinical symptoms, course and complications of the disease and discusses the question of spontaneous cure. He shows the importance of roentgen diagnosis in differentiating between subphrenic echinococcus of the liver and cysts of the base of the lung. He calls attention to the most common faults in the interpretation of the roentgenograms and emphasizes the importance of roentgen diagnosis as an aid in prognosis and a guide in surgical treatment. Finally he discusses recent experience in secondary canalicular dissemination of echinococci in the lung after expectoration of the primary cysts which have ruptured into the bronchi.—*Audrey G. Morgan.*

Evans, R. G. Prosser. Hydatid disease of the lung. *Lancet*, June 16, 1934, *1*, 1281–1283.

A case of hydatid disease of the lung is reported. For the past three years there has been

an average of 3 cases a year in the General Hospital in the Swansea area showing that it is not rare in some areas.

The initial chest roentgenograms showed a definite lesion occupying the greater part of the right hemithorax and showing various interesting features: (*a*) a well-defined lower and internal border; (*b*) an increase in the size of the right hemithorax, which may partly account for the lack of displacement of the thoracic viscera; (*c*) a gradual shading into general haziness of the upper and outer border, and (*d*) the pronounced peak of the diaphragm on the right side. From the above findings together with laboratory data and the history a diagnosis of pulmonary hydatid cyst was made. After four years' observation there has been some regression in size of the cystic condition and the patient appears well, which is in keeping with the diagnosis.—*L. H. Osmond.*

Vercesi, Romano. Rilievi radiomorfologici sull'idatide polmonare. (Roentgen study of the morphology of hydatid cysts of the lung.) *Arch. di radiol.*, Jan.–Feb., 1935, *11*, 36–47.

Béclère's classical description of the roentgen picture of echinococcus cyst of the lung is that it is a dense round shadow, generally spherical, homogeneous, with distinct outlines standing out clearly against the surrounding tissues. As a matter of fact, however, the shadow is generally not round but oval and this is a differential sign from other shadows in the lung. The lateral and oblique positions are best for showing the oval shape of the shadow. Even when the anteroposterior view shows a round shadow these projections generally show an ovoid form. Among the author's 24 cases, 17 were oval, 3 round and the other 4 irregular. Roentgenograms of these cysts are presented illustrating different points in his argument.

The form of the cyst may be changed by pressure from neighboring organs. The cardiovascular bundle particularly may change the form of paracardiac or mediastinal cysts giving atypical shadows or their form may be changed if they are very near to the diaphragm or the wall of the thorax.

Another point in Béclère's definition that is not strictly accurate relates to the smooth outline of the shadow. As a matter of fact the outline is generally rather indistinct. Sarcomatous tumors are more apt to give smooth, sharply defined outlines. This is probably partly due to the improvements that have been made in roentgen technique since Béclère's time. Irregularities in the outline of the reactive tissue are shown by the sharper technique of today that were not visible at that time.

The shadow of old cysts is denser than that of young ones. The capsule is formed by the products of metabolism of the parasites and with increasing age it becomes denser and thicker. The shadow made by the contents of the cyst is less dense. The shadow as a whole is generally less dense than that of solid tumors and uniform throughout. Pescatori says the cyst may be outlined by a delicate and very dense line caused by calcium incrustations but the author has not seen this in his cases. The age of the cyst may be judged to a certain extent by the density of the shadow.

The apparent density of the shadow is affected not only by the cyst itself but by the condition of the surrounding lung parenchyma. If aeration is normal the conditions for the visibility of the cyst are better. Often the cyst causes reactions in the adjacent tissue which change the form of the shadow. The cyst may cause connective proliferation in the tissue around it, giving rise to tracts of increased density radiating out from the cyst itself. If it is superficial or parietal it may cause pleural reactions; the parenchyma may also become involved, causing very complex images. If the shadows show evidence of adhesive processes collapse therapy is contraindicated and surgery indicated.

Before rupture when there is the simple oval shadow not very dense and homogeneous and with rather indistinct outlines diagnosis is comparatively easy but with rupture or gradual discharge of the contents of the cyst complications develop which make diagnosis very difficult.—*Audrey G. Morgan.*

Benassi, Enrico. Cisticercosi polmonare diagnosticata coll'esame radiologico. (Cysticercosis of the lung diagnosed by roentgen examination.) *Radiol. med.*, May, 1935, *22*, 506–515.

The author describes a case of cysticercosis of the lungs diagnosed by roentgen examination; he thinks it is the first case that has been controlled by biopsy and in all probability the first case of this type of lung lesion that has been diagnosed by roentgen examination.

The patient was a man of thirty-four without any family or personal history of any im-

portance. He had the clinical signs of subacute pleurisy. Roentgen examination showed both lung fields strewn with innumerable small parenchymatous nodules; their opacity was between that of fibrous tissue and calcium and in some places distinctly calcareous. The majority of these small shadows resembled those of miliary or submiliary tuberculosis in their size and distribution; in many places their outlines were finely fringed. They seemed to be situated at the crossing points of a reticulum of fine stripes, or at least along the course of radiating lines originating probably from interstitial sclerosis or chronic lymphangitis.

The roentgen diagnosis was suggested by the chance finding of some calcified cysticerci in the muscles of the axilla; it was verified by finding other cysticerci with the typical characteristics in other muscles. The roentgen diagnosis was confirmed by biopsy.—*Audrey G. Morgan.*

Hellmer, H. Fall von "primärer Dextroversion" des Herzens. (A case of primary dextroversion of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 591.

Hellmer describes and illustrates the roentgenograms of this rare cardiac anomaly on the basis of which the exact diagnosis was made. Autopsy confirmed it. The author presents detailed illustrations of the specimen.—*E. T. Leddy.*

Treiger, I., and Lundy, C. J. The correlation of shifting electrical axis of the heart with x-ray observations in artificial pneumothorax. *Am. Rev. Tuberc.*, 1934, *29*, 546–557.

The findings and conclusions from a study of 31 cases of artificial pneumothorax, 17 with left and 14 with right pneumothorax, are presented.

Artificial pneumothorax cases, with or without adhesions and fluid, show various gross changes in the direction of QRS in the first or third leads and increase or decrease in voltage of QRS in leads one, two and three. A decrease in voltage of QRS in one of the leads, usually the first or third, may make QRS of that lead less than 0.5 MV. These gross changes are approximate manifestations of shifting of the electrical axis and are subject to considerable error. The correct direction and degree of shifting can only be found by measurement of the QRS complexes and projection upon Einthoven's triangle.

Uncomplicated pneumothorax, left or right, shifts the electrical axis to the right. The degree of shifting depends upon the quality of the pneumothorax. The heart is displaced to the right by left pneumothorax and to the left by right pneumothorax. Pneumothorax, complicated by adhesions or fluid, may shift the electrical axis to the left. The degree of shifting depends upon the location, quantity, and quality of the adhesions and upon the quantity of fluid.—*L. H. Osmond.*

de Abreu, M. Röntgengeometric des Mediastinums. (Roentgenometry of the mediastinum.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 564.

This is another in the series of studies made by the author since 1924 on the geometry of the thorax. In this study he points out that the relative degrees of opacity of the intrathoracic structures in the roentgenogram are not entirely due to the relative opacities of the organs themselves but are due to the depth of the mediastinum and to the opposition planes of the lungs and mediastinum.—*E. T. Leddy.*

Kudisch, B. M., and Kamensky, E. A. Röntgenologische Analyse der Herzklappenfehler. (Roentgenologic analysis of valvular heart disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 480.

This study of 1,181 patients correlates the roentgen findings and pathologic anatomy of various types of valvular disease and the authors state that with some lesions the diagnosis can be made only by roentgenoscopy.—*E. T. Leddy.*

Klioner, I., and Ivanov, N. Die normale Herzkurve und die physiologischen Veränderungen derselben im Flächenkymogramm. (The normal cardiac curve and its physiologic changes in the kymogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 469.

In this paper the authors consider some of the factors that change cardiac pulsations in the kymogram, and pay special attention to the rôles of physical work, and the position of the body and state that their findings need to be confirmed by a study of a much larger group of cases.—*E. T. Leddy.*

Holst, L., Klioner, I., Koppelmann, S., and Speranskij, N. Die Flächenkymographie des

Herzens. (Surface kymography of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 454.

The authors here report and illustrate a critical study of 100 cases of various types of heart disease by the kymograph of Stumpf. They point out both where the method may be of value and where it may be of limited diagnostic value and feel that even though it is a valuable aid in diagnosis it cannot at present replace the electrocardiograph.—*E. T. Leddy.*

Holst, L. Flächenkymograph oder Einschlitzkymograph. (Surface kymograph or single slit kymograph.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 451.

Holst feels that the single slit kymograph is essential for the exact analysis of the surface kymogram in the study of movements of the heart and that kymography may in the future be substituted for certain phases of electrocardiography.—*E. T. Leddy.*

Cignolini, Pietro. Roentgenchimcgrafia. (Roentgen kymography.) *Radiol. med.*, Aug., *1935*, *22*, 791–794.

The author has shown in previous work that oblique fissures are sometimes necessary in roentgen kymography to at least partially correct the errors that result from registering oblique movements through transverse fissures. Oblique fissures are particularly useful for studying the diaphragm and the cardiovascular bundle at the same time, as the cardiovascular bundle moves along a horizontal axis while the diaphragm moves obliquely. To obtain a kymogram of the heart and vessels, therefore, the film should move downward vertically while for the diaphragm it should move horizontally. The oblique fissure obviates this difficulty with sufficient but not with perfect accuracy. It is impossible to find an inclination of the fissure which corresponds exactly to the axis of movement as this axis really varies somewhat during the phases of respiration. As a general rule, the author has found that fissures forming an angle of from 30° to 40° with the horizontal are the best adapted for the majority of cases. He gives roentgen kymograms illustrating the movements of the diaphragm under ordinary conditions and during attacks of coughing.—*Audrey G. Morgan.*

Barbacci, Gino. Contributo allo studio della pericardite calcifica. (Case of calcifying pericarditis.) *Radiol. med.*, May, 1935, *22*, 452–457.

Pericardial calcifications are quite rare and diagnosis during life is still rarer.

The author describes a case in a man of thirty-six who at the age of ten had had repeated attacks of parotitis without complications. In 1920 after a trauma he had a synovitis of the left knee which required about a year for cure and left a certain amount of rigidity of the joint. In the summer of 1925 he had a febrile disease the exact nature of which could not be determined as there was nothing to depend on but the patient's statements. After the fever was over he began to have vague epigastric pain and heaviness about two hours after meals, accompanied by palpitation of the heart, pain along the arms and sweating of the hands. When he took pepsin or other digestive preparations the symptoms were improved. A roentgen examination was made in 1932 to determine the nature of the digestive disturbance. The digestive tract was found normal but extensive calcifications of the pericardium were found. There was a star-shaped plaque over the left ventricle, a large mold surrounding the anteroinferior part of the right heart and smaller scattered calcifications elsewhere.

This case illustrates the difficulty in making a diagnosis of adhesive pericarditis. There were no characteristic symptoms in this case. The author thinks the digestive disturbances were probably caused by pericardial adhesions as they began about the time the pericarditis must have begun and there were no abnormalities of the digestive tract. They were evidently sympathetic in nature.

It is also difficult to determine the cause of the calcifying pericarditis in this case. It might have been initiated by the parotitis but the author is not inclined to think so. It might have been tuberculous as there were some slight signs in the lungs on physical examination and the synovitis of the knee may have been tuberculous. The author thinks it more probable, however, that the pericarditis was initiated by the indefinite fever, evidently an infectious disease and possibly melitensis, which the patient suffered just before the digestive disturbances began.—*Audrey G. Morgan.*

Oliveri, Antonio. Le dimensioni radiologiche del fascio cardiovascolare nelle eta fra i 3 ed

i 17 anni. (The roentgen dimensions of the cardiovascular shadow in subjects from three to seventeen years of age.) *Radiol. med.*, June, 1935, *22*, 608–616.

With the object of confirming the average heart sizes found in a study made by Cignolini, the author measured the shadow of the heart and great vessels on the teleroentgenograms of 337 individuals, both male and female, from three to seventeen years of age. He first describes the technique used and then gives a table showing the average, maximum and minimum values which he found. In studying the diameter of the heart in the two sexes he found it was slightly larger in the male than in the female. He also gives a curve showing the volumetric values in the two sexes. He also gives a comparative diagram showing the normal variations possible at the different ages. In another table he shows the average values which he himself found compared with the average values found by Cignolini. A careful analysis of the table shows that the values differ very little; the arithmetical average resulting from a comparison of the two is useful as a standard for the size of the normal cardiovascular shadow in subjects of these ages as it is based on the observation of more than 500 individuals.—*Audrey G. Morgan.*

DE ABREU, M. Differentialdiagnose von Geschwülsten der Aorta thoracalis. (Differential diagnosis of tumors of the thoracic aorta.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 575.

The author's thesis is that tumors of the thoracic aorta follow in their growth the laws of hydraulics and he states that this point may be of importance in the kymographic differential diagnosis of paramediastinal shadows.—*E. T. Leddy.*

CAPUA, ANTONIO. Su quattro casi di aneurisma della prima porrzione dell'aorta toracica. (Four cases of aneurysm of the first part of the thoracic aorta.) *Radiol. med.*, Sept., 1935, *22*, 847–854.

The author describes and illustrates with roentgenograms 4 cases of aneurysm of the first part of the thoracic aorta which present some unusual features. There was no doubt of the diagnosis of aneurysm in any of the cases. In 3 of the cases the arch also appeared to be dilated and calcified in places. The sac of the aneurysm was very large in all the cases. In 2 of them in the sagittal projection it extended into the right lung field and in the other 2 into both lung fields but predominantly into the right one. In the sagittal projection of the first, third and fourth cases the esophagus did not appear to be deviated and only to a slight degree in the second. But in the lateral projection it was greatly deviated forward in all the cases, surrounding the anterior part of the sac of the aneurysm which displaced and compressed it.

The author discusses the hypotheses advanced to explain these facts and emphasizes the importance of examination in the lateral projection in such cases.—*Audrey G. Morgan.*

SCHIFFER, ERNST. Die Bedeutung der Röntgenuntersuchung beim Verdacht auf Perforation der Speisseröhre durch verschluckte Fremdkörper. (The importance of roentgen examination in cases of suspected perforation of the esophagus by a swallowed foreign body.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 555.

The author reports 2 cases where repeated roentgen examination was of great value in establishing the diagnosis and treatment of mediastinitis following perforation of the esophagus by ingested foreign body.—*E. T. Leddy.*

MACMILLAN, A. S. Statistical study of diseases of the oesophagus. *Surg., Gynec. & Obst.*, Feb. 15, 1935, *60*, 394–402.

In the past ten years, 1,600 patients have been examined in the Out-Patient Department of Massachusetts General Hospital, because of dysphagia.

Foreign bodies were found to be present in 183, or 30 per cent, of those referred as suspicious. Over 90 per cent of foreign bodies lodge in the pyriform sinuses or upper third of the esophagus.

In the 878 cases in which dysphagia was not due to foreign bodies, 350, or 40 per cent, were due to malignancy. Males predominated over females, 6 to 1. There was little difference in frequency at different sites. Of those cases examined microscopically, 152 were epidermoid, 28 adenocarinoma, and 18 unclassified. From a roentgenological standpoint the lesion is easily differentiated from other lesions by the irregularity of the wall of the esophagus, the tortuous central opening, and the tumor mass with little

or no dilatation of the lumen above the obstruction.

Non-malignant strictures may occur at any portion but are most frequent in the upper third and lower end. When the musculature at the lower end of the esophagus becomes infected, and infiltration results with subsequent fibrosis of the circular or longitudinal muscle layer, the esophagus becomes dilated and elongated above the point of fibrosis. At the same time there is a clinical picture marked by dysphagia. This condition was first described by Rokitansky in 1840, and incorrectly termed cardiospasm by Mikulicz in 1882. Roentgen examination reveals a dilated, elongated, and atonic esophagus, filled with food and fluid to the level of the aortic arch, with the cardiac end of the esophagus constricted to an awl-like point. There is no spasm. As the fluid level rises, the obstruction at the lower end is overcome by hydrostatic pressure and the contents begin to enter the stomach in a thin stream. The condition predominates in females by a ratio of 3 to 1.

When infection and consequent fibrosis involve the upper third of the esophagus, there is a fusiform narrowing, but no dilatation above the point of constriction because of the ease with which food is regurgitated back into the pharynx. On roentgen examination, a thick barium paste will show a smooth fusiform narrowing of the upper end of the esophagus. The esophagus is not deviated from the midline, as it might be by an external pressure, and the mucous membrane pattern is entirely normal.

The next most common lesion occurs in the mucous membrane with the formation of partial diaphragms of mucous membrane or webs, with either a central or excentric opening. The roentgen picture is radically different from that of fibrosis. There is an abrupt, sharply defined narrowing at the location of the web. After passing this point the lumen regains its normal outline. Most frequent in females, 84 per cent. The marked relief that can be obtained by breaking or stretching this diaphragm of mucous membrane by instruments through the esophagoscope is spectacular

Dysphagia due to extrinsic causes such as tumors of the thyroid, larynx or enlarged glands constituted 3 per cent of the cases.

Burns of the esophagus from corrosives most often involve the middle third where there is a slowing of the ingested matter. When the mucous membrane alone is involved these result in thin membranous strictures which simulate webs. If the submucosal structures are involved, as occurs in 75 per cent of the burns, an irregular tubular stricture occurs of varying length and diameter.

Paralysis of the esophagus is rare but of the muscles of deglutition is common. The origin is central and is most frequently due to poliomyelitis, localized central hemorrhage, brain tumor, fracture at base of skull and Parkinson's disease. Roentgenoscopically the ingested material drops by gravity into the pharynx and completely fills this area. The pyriform sinuses are entirely flaccid. The esophagus does not open to receive the bolus as it normally should and the barium remains in the esophagus until expectorated.

Pouches are usually of the pulsion type, occurring in the middle third due to traction exerted on the esophageal wall by healing mediastinal glands. These pouches may occur above a stenosis. They rarely become large and rarely cause symptoms.

Pharyngeal diverticula occur most frequently in males—4 to 1. The diagnosis is made readily by roentgen examination. The pouch in the well-developed case appears to be a continuation of the lower pharynx while the mouth of the esophagus appears as an opening high up on the anterior wall of the pouch. The patient complains of dysphagia and a characteristic gurgling sound on swallowing.

Ulcers of the esophagus occur most frequently in young adults and at the lower end of the esophagus in islands of aberrant gastric mucosa. The roentgenoscopic examination reveals spasm of the esophagus with retention of a fleck of barium in the ulcerated area.—*J. H. Vastine.*

Becchini, Gastone. Antiperistalsi esofagea. (Antiperistalsis of the esophagus.) *Radiol. med.*, May, 1935, *22*, 503–506.

The author studied antiperistalsis of the esophagus by giving patients a bolus densely impregnated with barium and observing them roentgenologically while the bolus was being swallowed. He found that there is a true antiperistalsis of the esophagus. It may begin just above the cardia or higher up. It is a reflex undulating movement which may begin in a narrow ring or in a wider stretch of the esophagus; he has seen contracted tracts as wide as 2 cm. This wave of contraction is propagated upward

to varying distances. The movement is quite rapid and not rhythmical. It may not occur on the first or second bolus but may occur on later ones, or vice versa. It resembles duodenal antiperistalsis in being rapid and inconstant.—*Audrey G. Morgan.*

VANNUCCI, FERDINANDO. Di una grave ernia diaframmatica traumatica. (A case of large traumatic diaphragmatic hernia.) *Radiol. med.*, July, 1935, *22*, 693–700.

A case is described in a man of forty-three who was injured with a grenade in 1917. The projectile passed entirely through the left half of the thorax. An empyema developed and necessitated a thoracotomy. It was not until after the cure of the empyema that the symptoms developed which the patient has had ever since—dyspnea, feeling of weight in the epigastrium after eating, difficult digestion, better when the patient lies down after meals, borborygmus in the left half of the thorax after meals. Occasionally he had attacks of quite severe pain after a heavy meal with vomiting. The attacks have never been serious however. Roentgen examination in August, 1918, soon after the recovery from the empyema and the development of these symptoms showed hernia of the stomach and part of the colon into the left half of the thorax. In January, 1935, the patient came to the hospital for one of the attacks of pain and another roentgenogram showed practically the same findings—the stomach, the left half of the transverse colon and the first part of the descending colon were in the thorax, completely compressing the left half of the lung.

The remarkable points about this case were the enormous displacement of the abdominal viscera with only relatively slight symptoms and that the patient had had this condition for such a long time, seventeen years, without any serious ill effects.—*Audrey G. Morgan.*

ABDOMEN

KADRNKA, S. Observations radiologiques de l'automatisme de la formation des plis muqueux du tube digestif. (Roentgen study of automatism in the formation of the mucous folds in the digestive tract. *Acta radiol.*, 1935, *16*, 311–332.

The author reports observations made in the course of roentgen examination which give further support to Forssell's theory that the mucous membrane folds in the digestive tract are formed automatically. Changes took place in the relief of the mucous membrane in the intervals between contractions of the muscle wall under ordinary conditions or in experimental examinations, showing that the changes were not brought about by muscle contraction. The movements of the folds limited to the canal were observed on minimum distention of the stomach with a very thin layer of barium. More generalized movements were seen when the stomach was progressively dilated up to the usual classical filling.

Changes in the folds were made by the process of digestion independent of muscle movement. When meat was given the folds increased in number in the first stage of digestion and later in caliber and the "digestive pockets" formed by Forssell were seen. In the colon the caliber of the folds was increased by castor oil (the effect of congestion) and decreased by a saline purgative (the effect of withdrawal of water). Both the form and caliber of the folds varies depending on whether the examination is made after oral or rectal administration.

In interpreting roentgenograms it is necessary to be familiar with the functional changes in relief in order to be able to differentiate them from pathological changes. They may be brought about by various factors in the examination as well as by factors which have nothing to do with the method of examination. For instance, they may be affected by the temperature of the opaque substance, the presence of digestive juice on the surface of the mucous membrane, the condition of the intestine due to the previous administration of various purgatives or liquid enemas and the composition of the contrast medium. The technique used to make the folds visible must also be taken into consideration and the fact that the examination may have been made in the course of a medical treatment.—*Audrey G. Morgan.*

ARENDT, J. Die Bedeutung des Cannon-Böhmschen Punktes für die funktionelle Gliederung des Dickdarms. (The importance of the Cannon-Böhm point in the functional segmentation of the large intestine.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 508.

The Cannon-Böhm point is at the junction of the first and middle thirds of the transverse colon. It is not a sphincter but sometimes a contraction ring forms at this point due to dif-

ferent nerve supply of the colon above and below it. The two nerve supplies (from the sympathetic and para-sympathetic systems respectively) may work together or oppose each other. The latter occurs in "ascending colon obstipation" (Aszendenzobstipation). The second functional part of the colon has a specialized wave-like movement; that of the first part is of varying type of short wave movement. Antiperistalsis may occur. Incoördination of the lower colonic nerves secondary to kidney and pelvic disorders may lead to overstimulation of the bowel. Contraction of the second portion may result from various abdominal diseases extrinsic to the colon, such as gastric or duodenal ulcer, renal or pelvic disease.—*E. T. Leddy.*

Clausen, A. Fall von röntgenologisch wahrnehmbarer Magenamyloidose. (A case of gastric amyloidosis studied roentgenologically.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1935, *51*, 528.

The author's case, one of long-standing tuberculosis, had been diagnosed pyloric stenosis probably from tumor or fibrosis. At autopsy widespread amyloidosis of the stomach and other organs was found. From a review of the literature Clausen points out how the lesion is commonly mis-diagnosed carcinoma.—*E. T. Leddy.*

Cordiner, G. R. Mather, and Calthrop, G. T. Radiographic diagnosis of gastric and duodenal ulceration. *Lancet*, April 28, 1934, *1*, 885–888.

Berg's aimed closed compression exposure method is the most perfect method of examination at the present available for the diagnosis and investigation of gastric and duodenal ulceration. By its means the fleeting image of the screen is made permanent on the roentgenogram.

For the proper appreciation of the method a thorough knowledge of the roentgenographic appearances of the normal gastric and duodenal mucous membrane is required. From the fundus, where the folds are arranged as a complicated network, they run longitudinally through the body of the stomach. Usually two to four straight folds can be seen along the lesser curvature, constituting the "gastric street" or "pathway of Aschoff." On the greater curvature the arrangement of the folds commonly gives a dentate appearance, because folds running from the anterior to the posterior wall are seen at right angles. At the incisura angularis the longitudinal folds tend to become curved or spiral towards the greater curvature. Towards the pylorus the folds converge in a radial manner and are continuous with the folds visible in the pylorus itself. In the first part of the duodenum the folds are arranged longitudinally, as in the stomach, although a transverse arrangement may be visible during contractions.

Only the demonstration of the ulcer niche on the roentgenogram warrants a roentgenological diagnosis of the presence of ulceration. Every niche should, if possible, be shown in two planes, i.e., the ulcer niche in profile (first described by Haudek in 1910) and the ulcer niche "en face" called by Berg a "relief niche."

The recent ulcer, seen "en face," shows as a sharply defined round or oval punched-out area surrounded by a zone of inflammatory edema. As healing takes place the "en face" niche loses its definite outline, the circular inflammatory reaction disappears, the niche becomes smaller and irregular and there may be radial convergence of mucosal folds. Finally, a star-shaped scar replaces the niche. The profile niche varies greatly in appearance, being cup-shaped in the more recent ulcers and thorn or funnel-shaped in the more chronic forms. On either side is a concave indentation corresponding to the circular zone of inflammatory edema, of infiltrative thickening of the submucosa or of scar tissue formation and resultant contraction.—*L. H. Osmond.*

Wilbur, Dwight L., and Ochsner, Harold L. The association of polycythemia vera and peptic ulcer. *Ann. Int. Med.*, June, 1935, *8*, 1667–1672.

In an investigation of 143 cases of proved polycythemia vera, of which but 29 received gastrointestinal roentgen study, 12 cases, or 8 per cent, presented roentgenological or pathological evidence of peptic ulcer. A control group of cases of hypertension showed an incidence of but 2 per cent. In 10 cases with location in the duodenum, 9 were demonstrated by the roentgen examination, 1 by necropsy. Two of the patients gave no suggestive clinical symptoms. In 7 cases the ulcer history antedated that of the polycythemia vera by at least one year, in one patient by twenty-one years.—*W. R. Brooksher.*

Comando, Harry N. Primary isolated lymphogranulomatosis of the stomach. *Arch. Surg.*, Feb., 1935, *30*, 228–235.

Report is made of a case of lymphogranulomatosis of the stomach, the eighth recorded, in which roentgen study demonstrated an infiltrating lesion of the distal portion of the pars media and the proximal part of the pylorus. A partial gastrectomy was performed with subsequent full recovery. All recorded cases support surgery as the proper mode of therapy.—*W. R. Brooksher.*

Petersen, G. Fr. Contribution to the roentgen symptomatology of benign stomach tumors. *Acta radiol.*, 1935, *16*, 616–620.

Benign tumors of the stomach are rare and therefore the literature contains relatively little about them. The author describes 3 cases in which the roentgen diagnosis was confirmed by operation. Examination in the first case showed a polyp of the mucous membrane, in the second a myoma complicated by juxtapyloric ulcer and in the third a papillary adenoma. He then discusses a case described by Claessen of hydatid tumor in the wall of the stomach. He discusses the roentgen symptoms, and in each case the history, clinical data, the results of operation and its effects.—*Audrey G. Morgan.*

Matteucci, Eugenio. Aspetto radiologico dello stomaco dopo l'operazione di Judd. (Roentgen appearance of the stomach after Judd's operation.) *Radiol. med.*, Aug., 1935, *22*, 787–790.

Judd's operation is one of the newer operations used in the treatment of gastroduodenal ulcer. It consists in resection of the anterior wall of the bulb of the duodenum, a frequent site of duodenal ulcer and of the two anterior thirds of the pyloric sphincter; the lateral margins of the transverse opening are sutured with median vertical sutures. The author made roentgen examinations of patients after this operation. He found that the stomach filled quickly with opaque paste as if it were an inert sac but that it emptied very slowly as if gastric tonus were decreased, that of the circular fibers being affected more than that of the longitudinal fibers. This condition of complete inertia may last more than an hour and then very slow peristaltic movements begin. Complete emptying of the stomach required more than five hours while under normal conditions it takes place in two hours. Rapid roentgenograms in series showed in some cases a picture of diverticulum high up in the first portion of the duodenum; they were in the tract immediately below the gastroduodenal suture. With Vallebona's combined method with the patient lying down the new opening could be distinctly seen.

The author believes the decreased motility is caused by two factors—first, the dilution of the acid gastric juice by the alkaline intestinal fluid, and, second, impotence of the neurovegetative nervous system of the stomach caused by the operation on the pyloric sphincter.—*Audrey G. Morgan.*

Frimann-Dahl, J. Über den Nachweis der sogenannten kongenitalen Pylorus-Hypertrophie durch Röntgenuntersuchung. (The demonstration of so-called hypertrophy of the pylorus by roentgen examination.) *Acta radiol.*, 1935, *16*, 333–344.

The author maintains that the so-called hypertrophy of the pylorus is not really a hypertrophy of the pyloric ring but of the prepyloric canal, the canalis egestorius. Ordinarily the roentgen diagnosis of this condition has been based on the indirect signs or enlarged stomach, retention, hyperperistalsis and a characteristic rhythm of peristalsis. The chief clinical sign is vomiting. But now it is possible to demonstrate it directly by showing the narrow needle-like lumen of the canal.

The child is examined after eight hours' fasting, being given 50 gm. or more of a thin aqueous barium solution (1:2) given from a nursing bottle or with a teaspoon in about fifteen minutes. It is not advisable to fill the stomach with a sound. The examination is best made with the child in the right abdominal position, so that the retroverted canal appears between the dilated stomach and the spinal column. The child is held in the examiner's hands so that the abdomen can be palpated and the contrast medium pressed through the narrow lumen of the canal into the duodenum. The hands must be protected with leaded gloves.

Three cases are described, the last of which came to autopsy as the child died of pyelonephritis. Autopsy showed that the needle-like lumen demonstrated in the roentgen examination was really the lumen of the hypertrophied canal and that the pyloric sphincter had little to do with the stenosis.—*Audrey G. Morgan.*

Ratti, Arduino. Sul comportamento radiologico del duodeno in presenza di tumor gastrici. (The roentgen appearance of the duodenum in tumor of the stomach.) *Radiol. med.*, Sept., 1935, *22*, 805–829.

In a study of many tumors of the stomach it has been found that in tumors of the lower part of the stomach there are quite frequently functional changes in the duodenum consisting chiefly of an atony of the bulb or a stasis of the inferior flexure. These changes are found not only in cases of incontinence of the pylorus but also in cases in which the emptying time is retarded. The various forms of stasis of the duodenum in the different portions of the organ are illustrated with roentgenograms and their relation to the special site and extent of the tumor of the stomach discussed. This stasis of the duodenum seems to be functional rather than mechanical in the majority of cases and by a careful study of its site and form it may be possible to draw certain conclusions in regard to the extent and diffusion of the stomach tumor which is causing it. Stasis in the lower part of the duodenum is of the greatest significance as it is due to secondary diffusion of the tumor to the adjacent peritoneum or glands.—*Audrey G. Morgan.*

Balaban, I. J. Zur Kasuistik der Choledochoduodenostomie. (Passage of contrast from the duodenum to the bile ducts after choledochoduodenostomy.) *Acta radiol.*, 1935, *16*, 596–600.

The author describes a case in which contrast medium passed into the extra- and intra-hepatic bile ducts following choledochoduodenostomy for severe cholecystitis and compression of the cystic and common bile ducts by a tumor of the head of the pancreas. Although the contrast medium remained in the bile ducts longer than 120 hours after the meal there was no ascending infection. The increased bilirubin content in the blood serum and the presence of urobilin and urobilinogen in the urine probably indicated injury of the liver parenchyma. Roentgenograms of the case are presented.—*Audrey G. Morgan.*

Baldelli, Giovanni. Sugli aspetti radiologici del bulbo duodenale ulceroso in rapporto alle fasi evolutive e alla durata della malattia. (Roentgen appearance of the ulcerated bulb of the duodenum with relation to the stages of development and the duration of the disease.) *Arch. di. radiol.*, Jan.–Feb., 1935, *11*, 5–28.

On the basis of a careful clinical and roentgen study of 50 cases of ulcer of the duodenum confirmed by operation, the author draws certain conclusions in regard to the roentgen appearance of the diseased duodenum at different stages of the disease. His findings are illustrated by roentgenograms.

The most important symptom, the niche, is found in about 70 per cent of the cases and its most frequent site is on the anterior surface of the bulb at an average distance of about 2 cm. from the pyloric ring and at this site it is most readily visible when the bulb is semi-evacuated. The niche is smaller at this site than at other sites, particularly on the posterior surface. The ulcer is generally solitary but is multiple in about 8 per cent of the cases.

In the first stage of the disease there are no malformations of the bulb. This stage lasts from a few months to a year or two after the beginning of symptoms. It is characterized by a superficial niche which may or may not be surrounded by a peri-ulcerous halo. There are no spastic or organic malformations of the bulb and the bulb is often dilated, hypotonic and fills readily with barium and empties slowly. The niche and the halo around the ulcer may disappear in periods of quiet and after hemorrhage. No signs of periduodenitis are found on operation.

In the second stage typical malformations are seen. This stage lasts from the second to the third year and is characterized by more marked and more extensive inflammation than the first stage. There are spastic and organic malformations and perivisceritis begins. There may be pseudo-diverticula which may reach a large size but are unstable. In this stage if the ulcer is marginal or paramarginal Åkerlund's typical butterfly or cockade pictures may be seen; if the ulcer is parietal the typical hour-glass in the middle of the bulb may be seen. Operation shows periduodenitis localized at the site of the spasms.

The third stage is that of atypical malformation. It is seen in ulcers five to seven years of age. The atypical malformations may show the coralliform, orchid or flame types, the niche may be more or less visible or it may be hard to individualize it among the images of pseudo-diverticulum from perivisceritis. Anatomically

the perivisceritis has extended to the greater part of the bulb, with a tendency to cicatrization and sclerosis of the walls.

The fourth stage is that of contraction and stenosis of the bulb. This includes ulcers from eight to ten years of age. The bulb is greatly contracted with the lumen often reduced to a very small canal with more or less regular and semi-rigid walls. If the niche is large and projected on the outline of the bulb it may be easy to see it, but generally it is not visible, probably from callosity of the margins which prevents the entrance of the barium, or from cicatrization.

Of course the boundary lines between the different stages are not always distinct and the times given are not definitely fixed as some cases progress more rapidly than others, but in general this classification holds good.—*Audrey G. Morgan.*

Abell, Irvin, The diagnosis and treatment of diverticulitis and diverticulosis. *Surg., Gynec., & Obst.*, Feb. 15, 1935, *60*, 370–378.

Diverticula are noted at all points in the intestinal tract from the pharyngo-esophageal junction to and including the rectum. They occur as sacculations projecting from varying portions of the circumference of the intestinal tube—mesenteric, antemesenteric and lateral. They may range in number from one to several hundred. They are usually single in the esophagus, single or comparatively few in the duodenum and jejunum, chiefly of the Meckel's type in the ileum and they reach their greatest profusion in the colon, particularly in the left half. Diverticula have been described as congenital or true, and acquired or false, the former containing all the coats of the intestinal tube, the latter representing protrusions or herniation of the mucous and submucous coats through apertures in the muscularis. The term diverticulosis connotes the presence of such sacculations while diverticulitis implies the varying changes which occur as the result of inflammation and irritation.

Pharyngo-esophageal Diverticula. The level of the lower border of the cricoid cartilage is an occasional site of pulsion diverticula. The longitudinal muscle fibers diverge at this point to their insertion in the cricoid cartilage; the gap created by this divergence is filled in with the transverse and oblique fibers of the inferior constrictors, forming a thin muscular coat weaker than the remaining portion of the pharyngo-esophageal tube. As a result of pressure from within, separation of the muscle fibers occurs coincident with a protusion of the mucosal coat. Always small in the beginning, they may attain almost incredible size. The entrance to the sac is always on the posterior wall but the sac itself as it develops pursues a downward course along the esophagus, far more frequently on the left than on the right side, exceptionally long ones reaching at times well into the thorax.

Deep-seated diverticula of the esophagus are much rarer than those at the upper end, are usually of the traction type, and rarely occasion symptoms unless associated with cardiospasm.

Duodenal Diverticula. These are not infrequent, being found in all three divisions of the duodenum. Diverticula are less frequently observed in the upper portion of the jejunum and with the exception of the diverticulum of Meckel are seen but rarely in the ileum. The opening into the sac is situated on the mesenteric side. Both the congenital and acquired types are found in the small intestine, the latter being most frequent at and after middle age. They occur most frequently on the mesenteric side of the bowel where the vessels penetrate the muscularis, and they vary in depth from $\frac{1}{8}$ inch to 2 inches. The congenital or true type has been found in infants at birth and is usually single. The most frequent location in the duodenum is near the papilla of Vater. Diverticulosis of the small intestine may exist throughout life without giving rise to symptoms. Diagnosis cannot be made on clinical evidence alone; the condition however may be diagnosed with a high degree of accuracy by the roentgen ray. The complications of diverticulosis of the small intestine, which demand surgery for relief, are diverticulitis, suppuration, peridiverticulitis, perforation and intestinal obstruction.

Meckel's Diverticula. The most commonly observed diverticulum of the ileum is the persistent intra-abdominal portion of the vitelline duct. It may be found at any point of the small intestine below the duodenum, the usual location being from 10 to 30 inches above the ileocecal opening. Its usual attachment is antemesenteric and its length varies from a small protrusion to one $33\frac{1}{2}$ inches long. Its incidence as estimated from autopsy statistics varies from 1 to 2 per cent. It is a prolific cause of intestinal obstruction as a result of its attachment to the

umbilicus or to some other portion of the parietal peritoneum, mesentery or intestine, resulting in constriction, bend or kinking from traction. Diverticulitis closely resembles appendicitis in its symptoms and sequelae. Roentgen studies have been of little value in the recognition of Meckel's diverticulum (Pfahler has reported 2 cases recognized preoperatively; negative roentgen studies are sometimes helpful in arriving at a diaguosis by exclusion). Aschner and Karelitz in 1930 collected and studied 33 reported cases of peptic ulcer in Meckel's diverticulum and the ileum. The most common symptom was the passage of fresh blood and clots per rectum.

Diverticula of the Colon. These are by far the most frequently found diverticula, occurring in 5 per cent of all persons over forty years of age. Eighty-five per cent occur in the descending colon and sigmoid, and practically all are of the acquired type consisting of mucosa and submucosa covered with peritoneum. There are no symptoms referable to simple diverticulosis. The percentage of such cases that ultimately develop diverticulitis and present subjective symptoms is conjectural, but has been estimated at from 10 to 20 per cent. In the presence of diverticulitis one of several results may follow: namely, resolution, perforation with resultant diffuse peritonitis, abscess; perforation into a surrounding viscus; ischiorectal abscess; and thickening of the gut wall, mesocolic, and surrounding fat so that obstructions of varying degrees result. Roentgen study constitutes the most important aid in diagnosis, not only locating the site of the lesion but determining as well the extent of the involvement.

A study of the recent literature indicates the incidence of carcinoma developing on diverticulitis at from 1.7 to 8 per cent.—*J. H. Vastine.*

Stenström, Bo. Das Polyposisähnliche Kolonrelief, unter Unständen ein Röntgensymptom bei Pankreasaffektionen. (A colon relief resembling that of polyposis which is under some circumstances a roentgen symptom in diseases of the pancreas.) *Acta radiol.*, 1935, *16*, 589–595.

The author gives a brief review of the roentgen symptoms generally seen in diseases of the pancreas and calls attention to the fact that some of the fatty feces which are characteristic of this disease may adhere to the walls of the intestine. In that case the relief after a roentgen enema resembles the picture caused by polyposis and the author considers this one of the indirect signs of disease of the pancreas. He discusses the differential diagnosis of this condition from polyposis. He describes and illustrates with roentgenograms 4 cases of disease of the pancreas in which pronounced changes in the relief of the intestine of this nature were found.—*Audrey G. Morgan.*

Fitzwilliams, Duncan C. L. Carcinoma of the rectum. *Lancet*, April 21, 1934, *1*, 842–844.

There are three varieties or forms of growth in rectal carcinoma: (1) the papilloma or cauliflower mass where growth is pronounced and ulceration is at a minimum; (2) the adenoid or common form is the opposite, as here growth is at a minimum and destruction is at a maximum; (3) the colloid form is rare and is really a degeneration of the other two types.

The method of spread is discussed, calling special attention to the frequency of metastasis to the liver by way of the veins of the bowel.

When the various conditions which exist in the rectum are considered there appears to be very little which can simulate a really established cancer. Intussusception of a simple papillomatous growth may take place, but the tumor can be felt floating in the bowel. The lumen is in the center. Some cases of diverticulitis may simulate early carcinoma, but the roentgen examination will distinguish them at once. In diagnosis the roentgen examination by means of the opaque enema gives a good idea of the extent of the growth and the mobility of the bowel.

In addition to the recognized forms of surgical procedure, the author believes radium therapy is of value in checking the growth of the tumor. A well-protected tube of radium containing about 30 mg. is passed through a narrow sigmoidoscope in the colostomy opening to the stricture. This is left in place five hours. The next day the same is done from the anal route. This is repeated until a dose of about 500 mg-hr. is given to the growth. This is repeated at monthly intervals for three months. At the end of that time the growth has almost disappeared, or at all events is sterilized and either does not grow at all or grows very slowly.—*L. H. Osmond.*

GYNECOLOGY AND OBSTETRICS

HAJKIS, MIRON. Radiographic evidence of live birth. *Lancet*, July 21, 1934, *2*, 124–135.

Roentgenographic study of 6 infants with extensive atelectasis which were born alive and survived for periods from five minutes to eight hours is presented. The author supports Sidney Smith's statement that if a child has not breathed the stomach and intestines contain no air. It is believed that the presence of air in the stomach and intestines is due to swallowing and peristalsis. Some experimental work was done on still-born infants which supports this view.

The author supports Dennen in the belief that roentgenography should be routine in the diagnosis of morbid conditions of the newly born and especially cyanosis, where it is of distinct help in determining the extent of atelectasis and the prognosis.—*L. H. Osmond.*

TOMMASELLI, A. Sulla inopportunita d' introdurre la placentografia nella practica radiologica ostetrica. (The inadvisability of introducing placentography into the roentgen practice of obstetrics.) *Arch. di radiol.*, Nov.–Dec., 1934, *10*, 763–789.

The author describes experiments in making the placenta visible in guinea pigs by means of roentgen examination after the administration of thorium preparations. The findings are illustrated by roentgenograms and histological descriptions and photomicrographs are given of the findings in the various organs after placentography. He concludes that it would be an absolute mistake to introduce the practice of placentography into obstetrics for the purpose of the diagnosis of pregnancy. The roentgen picture of the placenta is brought about by the deposition of thorium salts in the lacunar network of the placenta and so the organ cannot be rendered visible until near the end of the third month of pregnancy. Moreover the thorium salts have an injurious action on the organs of the mother, particularly the liver, and on the fetus.—*Audrey G. Morgan.*

GALIFI, LIBORIO. Valore dell'indagine radiologica in un caso di cisti ovarica. (Value of roentgen examination in a case of ovarian cysts.) *Radiol. med.*, Sept., 1935, *22*, 829–838.

A case is described in an unmarried woman twenty-four years of age who about two months before had begun to feel intense pain in the right lower quadrant of the abdomen which was attributed to appendicitis. After a few days another physician examined her and said she had an abdominal cyst. In the meantime the patient had noticed an enlargement of the abdomen. There were no special symptoms at first except a feeling of weight in the stomach but this was followed by difficulty in defecation and in urination which necessitated catheterization. Deep palpation showed a large hard elastic mass in the lower half of the abdomen and another mass in the right upper quadrant. Bimanual palpation did not show any connection between the kidney and the mass. This upper mass had escaped the attention of the other physicians and in fact of the author himself until its presence had been shown by two roentgenograms. Roentgen examination showed calcified spots in these masses which suggested that they were dermoid cysts and their location and the displacements of the intestine caused by them showed that they originated from the ovary. The one high up in the abdomen had a long pedicle. The diagnosis in this case would have been impossible without the roentgen examination. The appendix had been pushed upward and fixed in an abnormal position by adhesions. Deep palpation over it caused intense pain. The visibility of the outline of the lower cyst may not have been due to calcification of its wall but to the transparency of the colon surrounding it. Roentgen examination in different projections is of the greatest importance in the examination of these cases. As the teeth in the cysts are apt not to be mature they may be mistaken for ureteral calculi, a mistake which can be avoided by roentgen examination in different projections.—*Audrey G. Morgan.*

GENITOURINARY SYSTEM

CAHILL, GEORGE F. Air injection to demonstrate the adrenals by x-ray. *J. Urol.*, Sept., 1935, *34*, 238–243.

The author injects the measured amount of air directly into the perirenal space by direct pressure, making no attempt to determine the amount of pressure applied. The injected air can be displaced in the desired direction by manual pressure, slowly infiltrating through the fascial planes. Roentgenograms made twelve to thirty-six hours later are satisfactory for visualization. The method has been found to be of value in demonstrating both pathological

and normal adrenals. No ill effects have been observed. The technique is detailed and illustrative roentgenograms are presented.—*W. R. Brooksher.*

Turano, Luigi. Su alcuni aspetti pielografiche del "rene mobile." (Roentgen appearance of floating kidney.) *Radiol. med.*, July, 1935, *22*, 661–672.

The clinical symptoms of floating kidney are indefinite and it is sometimes of great importance to make a differential diagnosis. Roentgen examination is the only reliable means of making the diagnosis early. The author describes a sign which he has found very characteristic of floating kidney, particularly in the early stages. It is sometimes obscured in the later stages when there are serious symptoms such as hydronephrosis, hematuria, pyelonephritis, etc., but at that time the diagnosis can be made clinically.

The sign consists of a protrusion of the pelvis at about the middle of the upper-internal outline; it may be only a slight protrusion or an extreme one which may be called a real gibbus. This must be differentiated from the gibbus which appears in dilatation of the pelvis from obstruction to the outflow of urine, and from those transitory protrusions which occur at certain stages in the course of kidney function. In these cases there is a special arrangement of the ureter and pelvis which was described by Hutter and called the psoas sign. The median outline of the pelvis and the upper part of the ureter is adapted closely to the external margin of the psoas. This psoas sign does not appear in floating kidney.

Roentgenograms and diagrammatic sketches are given illustrating this sign.—*Audrey G. Morgan.*

Kjellberg, Sven Roland. Fälle mit geschichteten und facettierten Nierensteinen. (Cases with stratified and facetted kidney stones.) *Acta radiol.*, 1935, *16*, 571–576.

A number of authors have called attention to the fact that kidney stones may be facetted, particularly when several small stones lie together in a large cavity, as for example in a hydronephrotic kidney. The stones may also be stratified but it is very rare to find stones that are both stratified and facetted. The author describes 2 cases in which this occurred, making the stones look like gallstones, and cites the few cases that have been described in the literature.

One of the conditions necessary for the formation of stratified and facetted stones is the presence of pyonephrotic or hydronephrotic kidney. In order for a stone as large as that in one of the author's cases to develop and have the freedom of movement which is necessary for the production of facets the kidney pelvis must be considerably dilated.—*Audrey G. Morgan.*

NERVOUS SYSTEM

Porro, Nicolo. L'esplorazione radiologica dello spazio sotto-aracnoideo—mielografia. (The roentgen exploration of the subarachnoid space—myelography.) *Radiol. med.*, May, 1935, *22*, 457–486.

The author reviews the different methods that have been used to diagnose the localization of compressions of the spinal cord. Most of these methods, he says, only show the existence or the absence of partial or total block. Myelography is the only method which shows the exact site of the compression. It is true that in a few cases the introduction of air into the subarachnoid space may show the localization but in the majority of the cases the interpretation of the results is very difficult, as is admitted by Dandy himself, the author of the method. But with the use of a contrast medium not only is the localization shown but also its relation to the vertebral column, which is very useful to the surgeon; and by combining lumbar puncture with high puncture the surgeon may determine exactly the number of vertebrae that must be included in the laminectomy.

The author gives his reasons for preferring lipiodol as a contrast medium and describes its physicochemical and physiological properties as well as the contraindications of the method and its by-effects. He describes in detail the two techniques used—introduction of the lipiodol from below and from above.

Myelography is of special value in multiple tumors of the spinal cord which can often not be demonstrated in any other way. The surgeon may be certain that if there is permanent arrest of the lipiodol there is an organic lesion. The arrest must be durable, however; transitory and partial arrest with atypical images must be ignored.

However myelography does not show the nature of the compression. Certain typical pictures such as that of the helmet-shaped image

with the concavity toward the obstacle and serrated stripes of lipiodol surrounding a definite segment of the hypertrophied cord may justify a definite diagnosis of extramedullary tumor, which may be intradural or extradural while a festoon image is typical of intramedullary tumor. But a mere arrest of lipiodol does not show the nature of the compression and it is nccessary to study the history, make a careful neurological examination and a roentgen examination of the spinal column also. A thorough study of compression of the cord should include a complete neurological examination, a preliminary examination of the spinal cord in the anteroposterior and two lateral directions, examination of the spinal fluid and lipiodol examination of the subarachnoid space.

Seven typical cases are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Cardillo, Furio. Le alterazioni radiografiche della colonna nei tumori endorachidiani. (Roentgen changes in the spinal column in intraspinal tumors.) *Radiol. med.*, June, 1935, *22*, 563–579.

Twelve cases of intraspinal tumors are described and illustrated with roentgenograms. The author examined these cases carefully with a view to confirming or refuting the work of Elseberg and Dyke, who reported their findings in the *Bulletin of the Neurological Institute of New York* in 1934. They claim that tumors of the spinal cord can be localized by measuring the minimum distance between the internal margins of the peduncles of the vertebrae on the roentgenogram taken in the sagittal direction. In order to do this of course it is necessary to know the normal distances in the different vertebrae. They measured the distances in 100 normal subjects and worked out a graph showing the distances in the different segments of the normal spinal column. They also attach great importance to the form of the internal margin of the peduncles.

From a careful study of his own cases, the author comes to the conclusion that their method is of no value. There are, however, changes in the spinal column, in some cases gross, in some fine, which help in localizing an intraspinal tumor by means of simple roentgenographic examination, in about 40 per cent of the cases. There were such changes in 5 of his 12 cases. In the majority of the cases the changes were in the laminae and the roots of the arches and in the 2 cases of tumor of the cauda equina there were marked changes in the posterior part of the bodies of the vertebrae. This is logical as these are the parts that bound the vertebral canal and are first subject to pressure by the new-growth. The changes are generally of the nature of erosion and loss of substance, more rarely direct infiltration with tumor tissue. Increased density of the bone tissue is rarer and was found in only one of these cases.

The author believes that by careful study of the roentgenograms taken not only in the direct backward and forward positions but in the oblique direction it will be possible to localize intraspinal tumors in many cases without the use of myelography.—*Audrey G. Morgan.*

Kienböck, R., and Mayer, E. G. Über multiple Neurofibromatose. (Multiple neurofibromatosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1935, *51*, 387.

The authors describe a case of a young man who had had for years backache, fever and weakness. Tuberculous spondylitis was suspected. Roentgen examination of the chest showed a large lobulated tumor in the posterior mediastinum and marked erosion of the spine. A therapeutic test ruled out lymphogranuloma. A probable diagnosis was made of a neurofibroma of the sympathetic with secondary involvement of the skeleton and early transition to neurosarcoma.—*E. T. Leddy.*

SKELETAL SYSTEM

Higgins, J. B. Cleido-cranial dysostosis in the new-born. *Brit. J. Radiol.*, Sept., 1935, *8*, 588–596.

This comparatively rare condition of delayed development of the membranous bones of the skull and clavicles is discussed and an illustrative case with roentgenograms is presented. Of unknown etiology, amniotic bands, injury, heredity, germinal abnormalities and arrested development have been suggested as possible causes. The differential diagnosis must consider intrauterine fracture, traumatic fracture at delivery, anencephaly, chondrodystrophia, osteogenesis imperfecta, fetal rickets, syphilis and cretinism. The possibility of confusion in medicolegal work is mentioned. —*W. R. Brooksher.*

Platt, Robert, and Owen, Trevor K. Renal dwarfism associated with calcification of arteries and skin. *Lancet*, July 21, 1934, *2*, 135–136.

An extensive search has revealed only 2 cases showing calcification of the arteries in chronic nephritis of childhood (renal dwarfism). In one case five markedly enlarged parathyroids were discovered and in the other case large doses of viosterol had been given before the calcification was noted.

A case is reported in which no vitamin D had been administered and no enlarged parathyroids were found.—*L.H. Osmond.*

Rodgers, T. Stanley, Peck, J. R. S., and Jupe, M. H. Lead poisoning in children. *Lancet*, July 21, 1934, *2*, 129–133.

The importance of roentgenography in the diagnosis of lead poisoning in children is illustrated by a case report, and a brief outline is given of the effects of lead on the body and the clinical aspects of poisoning in children. This is the first reference to lead poisoning in children in the English literature since 1890.

The roentgenographic changes produced by lead in the bones of children and young animals as described by Park in 1930 and by Vogt and Coffey shortly afterwards is given together with differential features from scurvy, congenital syphilis, healing rickets, and Albers-Schönberg's disease (Albers-Schönberg's disease is rare and must be distinguished by the history and clinical methods. In some there is a widening of the end of the bone, best seen at the lower end of the femur).—*L. H. Osmond.*

Paucke, A. Calcinosis interstitialis universalis, *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1935, *51*, 602.

This is an uncommon disease of connective tissue with calcareous deposits in the skin around the larger joints. Paucke reports the case of a ten year old boy with this disease. He had limitation of motion in almost all his joints, particularly the hips and shoulders—around which some of the calcium deposits had ulcerated. Characteristic roentgenograms showing para-articular deposits of calcium are presented. The clinical aspects of this lesion are discussed on the basis of this case and a review of the literature.—*E. T. Leddy.*

Ramsdell, E. G. Calcinosis universalis. *West. J. Obst. & Gynec.*, Nov., 1935, *45*, 624–635.

The author reports a case of general calcinosis in a ten year old girl in which there was immediate improvement of the vasospasm with absorption of the calcium deposits following unilateral thyroidectomy and an attempted parathyroidectomy. The thyroid presented hyperplasia but no demonstrable pathology was noted in the parathyroid. Clinically the patient presented a period of long-continued fever, loss of weight in marked degree, scleroderma and the deposition of large amounts of calcium in the subcutaneous tissues, together with a peripheral vasospasm. Blood calcium and blood phosphorus were normal. An underlying disturbance of the thyroid and the parathyroid is considered the most probable etiological factor.—*W. R. Brooksher.*

Enzer, Norbert, and Lieberman, Benjamin. Multiple myeloma. *Ann. Int. Med.*, March, 1935, *8*, 1062–1070.

A case of multiple myeloma clinically suggesting hyperparathyroidism is reported. Following surgical exploration of the neck for a parathyroid tumor, the patient succumbed to bronchopneumonia. A careful search at necropsy revealed no evidence of parathyroid tissue. The similarity between myelomatosis and hyperparathyroidism together with the laboratory methods for their differentiation is discussed.—*W. R. Brooksher.*

Petter, C. K., and Medelman, J. P. Tuberculosis of the shafts of long bones. *Am. Rev. Tuberc.*, Sept., 1935, *32*, 285–293.

Eight cases of tuberculosis of the shafts of long bones are reported in all of which definite pulmonary tuberculosis was present. The clinical symptoms were those of a low-grade bone abscess arising in the cancellous portion of the long bones and general toxic symptoms were not noted. The differential diagnosis from the clinical and roentgenological viewpoints must consider syphilis, pyogenic osteomyelitis and Brodie's abscess, occasionally blastomycosis and coccidioidal granuloma. The early roentgen findings appear in the cancellous portion as rounded, clear-cut areas of decreased density. No limiting region of bone sclerosis is observed nor any fading into normal osseous structures but rather an abrupt transition from the mar-

gins of these areas into apparently normal bone. As the process extends the film suggests erosion from within. As the periosteum is reached new bone is laid down.—*W. R. Brooksher.*

Dillehunt, Richard B. Osteomyelitis in infants. *Surg., Gynec. & Obst.*, July, 1935, *61*, 96–101.

In a child under thirteen years of age the following signs and symptoms suggest acute osteomyelitis: Abrupt onset with pain which remains constant, loss of function, tenderness over the end of the diaphysis, fever, leukocytosis, etc. Boils on the skin are the most frequent primary focus, otitis media next. In practically every instance osteomyelitis remains unrecognized and is therefore neglected in the early stage when treatment would do most to prevent unfortunate sequelae. These sequelae are extensive bone necrosis, multiple metastatic lesions, septic arthritis in the elbow and hip, fracture and deformity, cardiac lesions, secondary anemia and deformities due to disorders of bone growth.

Acute osteomyelitis is a disease exclusively of children; i.e., it is a hematogenous infection lodging in the end arteries and stagnant venous sinuses of the growing epiphysis. Osteomyelitis supervening in an adult is in all probability a lighting up of an ancient quiescent process acquired in childhood. The arteriovenous arrangement seems to be especially susceptible to the development of infection between the ages of five and eleven years. Fortunately, the epiphyseal cartilage is thick at this time and nearly always competent to prevent extension of infection to an adjacent joint. At the upper end of the femur and the lower end of the humerus, the epiphyses and the adjacent diaphyses are inside the joint capsule of hip and elbow, respectively; hence, rupture near the epiphysis is into the joint so that septic arthritis ensues. In all other joints there may be an effusion of fluid into the joint, rich in leukocytes, and which looks like pus but is sterile. In acute osteomyelitis of a vertebral body, similar effusion occurs into the spinal canal and may be associated with symptoms of meningeal irritation. The duration of the invalidism is in direct ratio to the delay in the recogniton of the condition in the acute stage. Secondary foci in other bones, because of immunization of the subject, are subacute in their evidences and hence easily overlooked.

The author reports 3 cases of acute osteomyelitis in infants under six months of age.—*J. H. Vastine.*

Roehm, Harold R. Primary costal osteomyelitis. *Ann. Int. Med.*, August, 1935, *9*, 200–206.

Report is made of a case of primary osteomyelitis of the fifth right rib in a nine year old boy in which the initial roentgen study made two weeks after onset was negative for rib pathology, but showed pleurisy and early pneumonic infiltration of the right upper lobe. An empyema subsequently developed and the rib condition was first demonstrated in a roentgenogram made thirty-seven days after onset of the disease. Drainage from the infected rib occurred apparently into the pleural cavity, contrary to the usual belief. Recovery ensued without operation other than thoracentesis. In this condition first symptoms were fever and localized pain; first signs, local tenderness, muscle spasm and pleural thickening accompanied by a rapidly developing empyema. Roentgen-ray evidence followed development of the empyema and its drainage.—*W. R. Brooksher.*

Zimmer, E. A. Die Syringomyelie unter Berücksichtigung ihrer röntgenologischen Diagnostik und therapeutischen Beeinflussung. (Syringomyelia with special reference to its roentgen diagnosis and treatment.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1935, *51*, 247.

The author discusses the pathologic anatomy, clinical evolution and roentgenologic characteristics of syringomyelia and places special emphasis on the changes in the bones and joints in this disease as illustrated by a case of kyphoscoliosis and one of at first atrophic type in the shoulder joint which in a four years' evolution changed to the hypertrophic type. The author discusses the various methods of treating the disease and favors roentgen therapy.—*E. T. Leddy.*

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FOREWORD

THIS NUMBER of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY is dedicated to George Winslow Holmes by his former students and associates on the occasion of the Sixtieth Anniversary of his birth and the Twenty-fifth Anniversary of his appointment as Roentgenologist to the Massachusetts General Hospital. The publication of this Anniversary Number is made possible through the kindness of the Editor of the JOURNAL, and the cooperation of those who have at one time served under Dr. Holmes for six months or longer in the Department of Roentgenology of the Massachusetts General Hospital as Assistant Roentgenologists, Residents, Graduate Assistants, and Graduate Students. All the papers contained herein were written by members of this group.

To our former Chief, who has endeared himself to all of us, we extend our heartiest congratulations and felicitations!

COMMITTEE FOR THE ANNIVERSARY NUMBER
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GEORGE W. HOLMES

UNIV. OF MICH.

GEORGE WINSLOW HOLMES

GRAHAM LUSK introduced the intellectual pedigree. He traced his own intellectual ancestry to Lavoisier. George Holmes' intellectual pedigree is shorter, his science being younger than Lusk's. From the Adam of Roentgenology, Roentgen, he descends through Walter Dodd. To Dodd, his intellectual sire, he owes his inspiration and early training in the science and art. Never has a child more abundantly fulfilled the promise of a fine heritage. Holmes himself has now reached the grandfather stage in the production of radiologists. Among his children are such men as Sosman, Dresser, Camp, Golden, Reeves, Martin, Moore, Carty and Warren, and these men in turn have begotten intellectually a third generation. It is a happy thing that when man breeds intellectually at all he does so far more rapidly than he can in the carnal manner. Thus may he enjoy, as has George Holmes to the full, association with a large progeny.

Approaching more primitive considerations, we may say of Holmes that he is every inch a Down East Yankee with all the fine characteristics of that slowly vanishing race. Born and raised in the state of Maine, to which region his forbears migrated from Massachusetts before the Revolution, beside the lovely blue waters of Penobscot Bay, he got his schooling in Belfast's public schools and tuned his soul to the enveloping forests and streams. That is to say, he became a disciple of the immortal Isaak. To this communion with nature we may attribute, at least in part, that sweet serenity and noble humility which are among his outstanding attributes. Holmes is a simple man, if by simple we mean straightforward, unassuming, free from guile and pretension, content with his work and simple pleasures. Intellectually he is a superior man, full of good, common sense and clear understanding and penetration into the problems of his chosen subject. He is a good scientist because he combines keenness and honesty in observation with imagination and with sound critical judgment.

Everyone likes him because of his natural friendliness and unselfishness. Also, because he has a type of wit which makes him good company. I do not believe that Holmes ever made an enemy, and that refutes a wisecrack of one of my forbears, that a man who never makes enemies never makes anything. Holmes has made friends, contributions to radiology, and, as I said in the beginning, especially radiologists and good ones at that. If any of his pupils have turned out badly—and I do not know that any have—it can be through no fault of his. Although a Yankee of the Yankees—no one familiar with the breed could mistake him for anything else—he has endeared himself to men of every sort, Southerner and Westerner, Jew and Gentile, Occidental and Oriental, as well as his own kind. His friends and his pupils have come from all over the earth. As he has made friends through the beauty of his character, so, too, he has attracted pupils by the forthrightness and soundness of his teaching, by the breadth of his experience.

What actually indeed has been this experience? His professional experience began when he entered Tufts Medical School in 1902. He obtained his M.D. from that School in 1906. Following this he served internships at the Long Island Hospital and the South Department of the Boston City Hospital. Then, after another year at the Long Island Hospital as Resident, he began his career in Roentgenology under Walter Dodd, being given the title of Assistant in Roentgenology at the Massachusetts General Hospital, in the year 1911. He has worked full time in that institution ever since. His first appointment in the Harvard Medical School, that of Assistant in Roentgenology, was in 1913. In 1918 he was made a member of the Harvard Faculty as Instructor, and in 1931 began his Clinical Professorship in Roentgenology.

Under his leadership the volume of the work of his department and the department's contributions, both in men and knowledge, have shown a continuous growth. Handicapped always by inadequate quarters and not infrequently by inadequate apparatus,

Holmes has yet succeeded in making himself one of the most eminent clinical roentgenologists of the country, and of his department one of the chief centers of radiological education. Holmes has sent out about sixty men who were officially ranked under him either as assistants, residents, or volunteer graduate assistants in the hospital, serving six months or longer, and in addition to that there has been a large number of postgraduate students who have served under him for shorter periods. Also, for many years he has given instruction to those undergraduates of the Harvard Medical School who have been assigned for medicine and surgery to the Massachusetts General Hospital, and more lately has lectured to the entire third year class of Harvard Medical School. In recent years, therefore, all students of the Harvard Medical School have had some teaching from Holmes.

Through his publications, which deal with nearly every aspect of roentgenology, and particularly by means of his textbook, "Roentgen Interpretation," now going into its fifth edition (first edition, 1919), he has reached a still wider audience. The textbook is short, concise, packed with information, with facts far outweighing opinion or theory, a book typical of the Down East Yankee, not a word wasted.

In the short space allotted for this notice it is impossible even to enumerate Holmes' many contributions to the general fund of roentgenological information.

As we survey his career as a whole, outstanding is the great influence he has wielded for conservatism and sanity in a rapid, perhaps at times wildly growing specialty. By his own patient, deliberate and careful technique, his unbiased and logical thinking, and his courageous adherence to truth, he has set an example of honesty and intelligence in the practice of roentgenology, a gospel which his students have carried throughout the land.

Among Holmes' special achievements the formation of a tumor clinic ranks high. The idea back of this, that all specialists concerned in such cases should be represented in such a clinic and determine diagnosis and treatment by consultation, apparently originated with him. Certainly the Tumor Clinic of the Massachusetts General Hospital, now widely copied, had its birth in Holmes' department. Also, there it has remained ever since, with physicians and surgeons going thither to play their parts in the care of the patient. As a matter of fact, the Tumor Clinic had for its prototype the Thyroid Clinic, also a joint enterprise of medicine, surgery and roentgenology. The birthplace of this clinic also was in the Department of Roentgenology. Indeed one might truthfully say that the principle of the combined clinic was one of Holmes' major interests.

Never has Holmes been the narrow specialist. He has been, as should be all specialists, physician first, specialist afterwards. As roentgenologist he has ever worked hand in hand, seen eye to eye with physician and surgeon, always seeking to integrate the roentgenological aspects of a case or clinical problem with all other pertinent aspects. In the famous clinico-pathological conferences, instituted by Cabot, Holmes has made the roentgenologist one of an indispensable trio of clinician, roentgenologist and pathologist.

The roentgenologist is seldom in charge of the patient yet he handles the patient, often knows the patient, and therefore must practice the same consideration for the patient and strive to understand him, as does the family doctor. In this respect, as in others, Holmes has been successful. His calm, gentle personality, his instinctive kindliness give reassurance; the wisdom and understanding shining from his mild blue eyes inspire confidence. Always will a patient undergoing a roentgen examination have some dread of what may be discovered. Under the care of Holmes this dread is mitigated. He is, in other words, a good physician.

In this Anniversary Number, Holmes' pupils present in homage and affection the fruits of their labors, and it is no mean harvest. Could his patients take part they would offer affection as well as gratitude. Knowing these things, Holmes may say to himself, without trace of conceit (of which, incidentally, he is incapable), "I have not lived in vain."

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